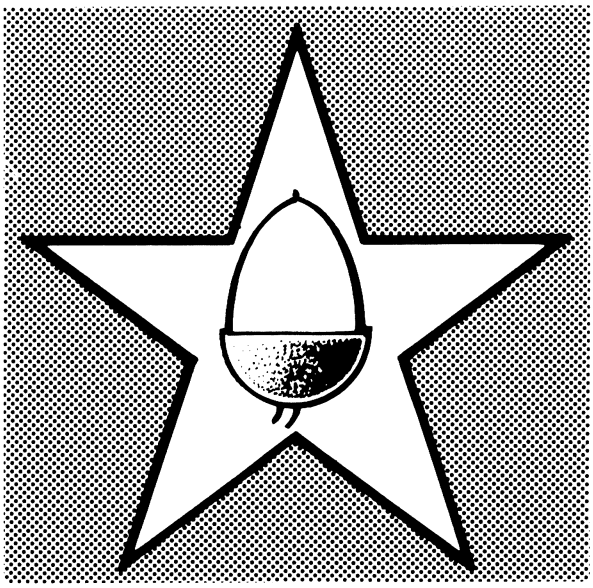
ANNEXES TO THE SUSTAINABILITY OF THE SOVIET ARMY IN BATTLE



SOVIET STUDIES RESEARCH CENTRE

RMA SANDHURST

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Consultant Report STC CR-65

ANNEXES TO THE REPORT ON

THE SUSTAINABILITY OF THE SOVIET ARMY IN BATTLE

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PREFACE

This Appendix to the Report on the Sustainability of the Soviet Army in Battle, and the report itself, were prepared under contract to SHAPE Technical Centre by the staff of the Soviet Studies Research Centre at Sandhurst (UK) through John Bell Technical Systems in support of STC's programme of work for 1986. It presents a Soviet perspective of the problems of sustaining the viability of their forces in combat.

The views expressed are those of the individual contributors and do not necessarily reflect the views of the UK MOD, SHAPE or STC. The report is not classified, nor has any classified information been used in its preparation. It should not be used outside official circles without prior reference to the authors or STC.

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ANNEX A

EXAMPLES OF OPERATIONAL PLANNING DOCUMENTS FOR ASSESSING FORCE RATIOS AND VIABILITY.

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The material in this annex and the relevant material in Chapter 2 Section 5 is courtesy of the US Army's Soviet Army Studies Office, Fort Leavenworth.

Appendix 1 to Annex A

Table 40. Composition of Forces and Density.

SOVIET		FORCES AND EQUIPMENT	ENEMY	
RATIO PER/KM	TOTAL		TOTAL	PER/KM
		1. AT START OF OPERATION OVER ENTIRE FRONTAGE AND DEPTH		
		A. NUCLEAR ROUNDS		
		B. NUCLEAR DELIVERY MEANS. TACTICAL OPERATIONAL SSM AIRCRAFT TACTICAL SSM NUCLEAR ARTILLERY		
		C. DIVISIONS MRD TK		
		D. TANK		
		E. ARTY AND MORTARS 100MM+ 100MM		
		F. ATGM		
		G. AIR DEFENCE HIGH ALTITUDE LOW ALTITUDE		
		H. AIRCRAFT FIGHTER BOMBERS BOMBERS FIGHTERS		

Table 41. Composition of Forces and Density.

SOVIET		FORCES AND EQUIPMENT	ENEMY	
RATIO PER/KM	TOTAL		TOTAL	PER/KM
		2. ON AXIS OF MAIN ATTACK OVER ENTIRE FRONTAGE AND DEPTH		
		A. NUCLEAR ROUNDS		
		B. NUCLEAR DELIVERY MEANS. TACTICAL OPERATIONAL SSM AIRCRAFT TACTICAL SSM NUCLEAR ARTILLERY		
		C. DIVISIONS MRD TK		
		D. TANK		
		E. ARTY AND MORTARS 100MM+ 100MM		
		F. ATGM		
		G. AIR DEFENCE HIGH ALTITUDE LOW ALTITUDE		
		H. AIRCRAFT FIGHTER BOMBERS BOMBERS FIGHTERS		

Table 42. Composition of Forces and Density.

SOVIET		FORCES AND EQUIPMENT	ENEMY	
RATIO PER/KM	TOTAL		TOTAL	PER/KM
		3. ON SECONDARY AXIS OVER ENTIRE FRONTAGE AND DEPTH		
		A. NUCLEAR ROUNDS		
		B. NUCLEAR DELIVERY MEANS. TACTICAL OPERATIONAL SSM AIRCRAFT TACTICAL SSM NUCLEAR ARTILLERY		
		C. DIVISIONS MRD TK		
		D. TANK		
		E. ARTY AND MORTARS 100MM+ 100MM		
		F. ATGM		
		G. AIR DEFENCE HIGH ALTITUDE LOW ALTITUDE		
		H. AIRCRAFT FIGHTER BOMBERS BOMBERS FIGHTERS		

Table 43. Composition of Forces and Density.

SOVIET		FORCES AND EQUIPMENT	ENEMY	
RATIO PER/KM	TOTAL		TOTAL	PER/KM
		4. AFTER INITIAL NUCLEAR STRIKE OVER ENTIRE FRONTAGE AND DEPTH		
		A. NUCLEAR ROUNDS		
		B. NUCLEAR DELIVERY MEANS. TACTICAL OPERATIONAL SSM AIRCRAFT TACTICAL SSM NUCLEAR ARTILLERY		
		C. DIVISIONS MRD TK		
		D. TANK		
		E. ARTY AND MORTARS 100MM+ 100MM		
		F. ATGM		
		G. AIR DEFENCE HIGH ALTITUDE LOW ALTITUDE		
		H. AIRCRAFT FIGHTER BOMBERS BOMBERS FIGHTERS		

Table 44. Composition of Forces and Density.

SOVIET		FORCES AND EQUIPMENT	ENEMY	
RATIO PER/KM	TOTAL		TOTAL	PER/KM
		5. AT END OF 1ST DAY OF OPERATION OVER ENTIRE FRONTAGE AND DEPTH		
		A. NUCLEAR ROUNDS		
		B. NUCLEAR DELIVERY MEANS. TACTICAL OPERATIONAL SSM AIRCRAFT TACTICAL SSM NUCLEAR ARTILLERY		
		C. DIVISIONS MRD TK		
		D. TANK		
		E. ARTY AND MORTARS 100MM+ 100MM		
		F. ATGM		
		G. AIR DEFENCE HIGH ALTITUDE LOW ALTITUDE		
		H. AIRCRAFT FIGHTER BOMBERS BOMBERS FIGHTERS		

Table 45. Composition of Forces and Density.

SOVIET		FORCES AND EQUIPMENT	ENEMY	
RATIO PER/KM	TOTAL		TOTAL	PER/KM
		6. ON ACHIEVEMENT OF IMMEDIATE OBJECTIVE OF ARMIES OVER ENTIRE FRONTAGE AND DEPTH		
		A. NUCLEAR ROUNDS		
		B. NUCLEAR DELIVERY MEANS. TACTICAL OPERATIONAL SSM AIRCRAFT TACTICAL SSM NUCLEAR ARTILLERY		
		C. DIVISIONS MRD TK		
		D. TANK		
		E. ARTY AND MORTARS 100MM+ 100MM		
		F. ATGM		
		G. AIR DEFENCE HIGH ALTITUDE LOW ALTITUDE		
		H. AIRCRAFT FIGHTER BOMBERS BOMBERS FIGHTERS		

Table 46. Composition of Forces and Density.

SOVIET		FORCES AND EQUIPMENT	ENEMY	
RATIO PER/KM	TOTAL		TOTAL	PER/KM
		7. ON ACHIEVEMENT END OF IMMEDIATE OBJECTIVE OF FRONT OVER ENTIRE FRONTAGE AND DEPTH		
		A. NUCLEAR ROUNDS		
		B. NUCLEAR DELIVERY MEANS. TACTICAL OPERATIONAL SSM AIRCRAFT TACTICAL SSM NUCLEAR ARTILLERY		
		C. DIVISIONS MRD TK		
		D. TANK		
		E. ARTY AND MORTARS 100MM+ 100MM		
		F. ATGM		
		G. AIR DEFENCE HIGH ALTITUDE LOW ALTITUDE		
		H. AIRCRAFT FIGHTER BOMBERS BOMBERS FIGHTERS		

Table 47. Composition of Forces and Density.

SOVIET		FORCES AND EQUIPMENT	ENEMY	
RATIO PER/KM	TOTAL		TOTAL	PER/KM
		8. AT END OF SUBSEQUENT OBJECTIVE OF FRONT OVER ENTIRE FRONTAGE AND DEPTH		
		A. NUCLEAR ROUNDS		
		B. NUCLEAR DELIVERY MEANS. TACTICAL OPERATIONAL SSM AIRCRAFT TACTICAL SSM NUCLEAR ARTILLERY		
		C. DIVISIONS MRD TK		
		D. TANK		
		E. ARTY AND MORTARS 100MM+ 100MM		
		F. ATGM		
		G. AIR DEFENCE HIGH ALTITUDE LOW ALTITUDE		
		H. AIRCRAFT FIGHTER BOMBERS BOMBERS FIGHTERS		

Appendix 2 to Annex A

Availability of Forces and Weapons.

Table 48. Availability, Time of Use, and Distribution of Chemical and Nuclear Weapons.

TASKS DELIVERY MEANS	DIVISION 3 10 20	ARMY 20 40 100	FRONT 20 40 100	RESERVE TVD	SRF THEATRE ROCKETS	AIR FORCE	TOTAL	CHEMICAL ROCKETS
TOTAL OPERATION								
AVAILABLE NOW								
WILL ARRIVE:								
1ST DAY								
2ND DAY								
3RD DAY								
ETC.								
DISTRIBUTION PER TASK:								
INITIAL STRIKE								
ENEMY NUC WPNS								
GROUND FORCE UNIT								
PVO								
COMMAND POSTS								
AIRFIELDS								
IMMEDIATE MISSION:								
REPEL COUNTER-ATTACK								

TASKS DELIVERY MEANS	DIVISION 3 10 20	ARMY 20 40 100	FRONT 20 40 100	RESERVE TVD	SRF THEATRE ROCKETS	AIR FORCE	TOTAL	CHEMICAL ROCKETS
RIVER CROSSING								
ETC.								
SUBSEQUENT MISSION:								
FRONTAL RESERVE								
DISTRIBUTED TO ARMIES:								
2nd G								
NGF								
20th G								
8th G								
1st G TK. A.								
3 SHOCK A.								

Table 49. Availability and Technical Condition of Tanks, SP Guns and Armoured Vehicles at Start of Operation.

ARMIES	2 G			NORTHERN			20 G			8 G		
	TANK	ARTY	BMP	TANK	ARTY	BMP	TANK	ARTY	BMP	TANK	ARTY	BMP
OPERATIONAL												
KM BEFORE MAINTENANCE												
3500												
3000												
2000												
1500												
1000												
IN REPAIR NOW												
LIGHT												
MEDIUM												

ARMIES	1 G TANK			3 SHOCK		
	TANK	ARTY	BMP	TANK	ARTY	BMP
OPERATIONAL						
KM BEFORE MAINTENANCE						
3500						
3000						
2000						
1500						
1000						
IN REPAIR NOW						
LIGHT						
MEDIUM						

Table 50. Supplies and Materiel.

TYPE OF SUPPLY

TOTAL FOR OPERATION	AMMUNITION									
	ARTILLERY	ROCKET	TANK	ANTI TANK	ATGM	SA	SAM	AAA	BOMB	AIR AMMO
AVAILABLE IN TROOP UNITS										
IN FRONT DEPOTS										
WILL RECEIVE EXPENDITURE										
REMAINING AT END										

TOTAL FOR OPERATION	ROCKET FUEL	POL			FOOD
		GAS	DIESEL	AIR	
AVAILABLE IN TROOP UNITS					
IN FRONT DEPOTS					
WILL RECEIVE EXPENDITURE					
REMAINING AT END					

Table 51. Distribution of Air Sorties.

MISSIONS / UNITS	COMBAT COMPOSITION	TOTAL EMPLOYMENT	INITIAL NUCLEAR STRIKE	IMMEDIATE MISSION	SUBSEQUENT MISSION	RESERVE
FIGHTER						
FIGHTER BOMBER						
BOMBER						
TOTAL						
AIR RECCE						

Table 52. Signal Plan.

MEANING OF SIGNAL	RADIO AND TELEGRAPH	TELEPHONE	ACKNOWLEDGEMENT	
			RADIO	TELEPHONE

Table 53. Distribution of Support Units.

	ARMY & FRONT RESERVE	ROCKET & ARTY	AIR DEFENCE	ENGINEER	CHEMICAL
2 GA					
NG ARMY					
20 GA					
1 GTA					
8 GA					
3 SA					
RESERVE DIVISION					
FRONT MOBILE OBSTACLE DET					
UNDER DIRECT CONTROL					

Appendix 3 to Annex A

Table 54. Annex to Front Plan.

COMBAT OPERATIONS SCHEDULE

PHASE	1ST ECH ARMY	2ND ECH ARMY	RESERVE	SSM	ARTY	AT	PVO	AIR	AIR ARMY
INITIAL NUC STRIKE									
ARTY PREP	In these blocks are shown the specific details who, where, when, what group, etc. with reference to the annexes. This shows how each phase is accomplished including the predicted enemy actions and what is done about them. It shows the duration and phases of the various artillery strikes, how many aircraft are allocated to each axis and event, and what each army and reserve division does.								
FIRST DAY									
DEFEAT ENEMY COUNTER-ATTACK									
COMMIT 2ND ECHELON									
IMMEDIATE FRONT OBJECT	This schedule is written during the 'organization of combat' phase and is an annex to the plan.								
CROSSING RIVER RHINE									
OPERATIONAL AIR ASSAULT LANDING									
NAVAL ASSAULT									
SUBSEQUENT FRONT OBJECT									

ANNEX B

STATISTICS OF OPERATIONAL AND TACTICAL NORMS.

			Page
Details are contained in the list of Appendices below:			
Average densities of manpower/weapons in breakthrough sector together with scale of front offensive operations in GPW.	Appendix 1	(Tables 55-56)	441
Massing of forces and weaponry on the main axis	Appendix 2	(Table 57)	443
Scale of army offensive operations from July 1943	Appendix 3	(Table 58)	444
Examples of offensive operations of tank armies 1943-1945	Appendix 4	(Table 59)	446
Density of artillery in breakthrough sectors in army offensive operations 1944-1945	Appendix 5	(Table 60)	449
Distance and time dispersion of tank armies before battle	Appendix 6	(Table 61)	450
Preparation time for tank army operations in GPW	Appendix 7	(Table 62)	451
Comparison of operational densities of Soviet and German forces at start of East Prussia Operation	Appendix 8	(Tables 63-64)	453
Operational structuring of the fronts and combined arms armies at the start of the Visla-Oder Operation	Appendix 9	(Table 65)	455
Operational density of arty, tanks, SP guns and infantry at the beginning of the Visla-Oder Operation	Appendix 10	(Tables 66-67)	457

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Operational structuring of the fronts at the start of the Berlin Operation	Appendix 11 (Table 68)	459
Artillery Grouping of 8 Guards Army on 16 April 1945 (Berlin Operation)	Appendix 12 (Figure 24)	461
Copy of Sketch map of Fireplan-8 Guards Army in Berlin Operation	Appendix 13 (Figure 25)	462

NB. 1st Period of the Great Patriotic War (GPW) - June 1941-December 1942.

2nd Period of GPW - January 1943-June 1944.

3rd Period of GPW - June 1944 - May 1945.

Appendix 1 to Annex B

Table 55.* Average Densities of Manpower and Weapons in Breakthrough Sectors.

Manpower and Weapons	Average Density on 1km of Breakthrough Sector		
	1st Period	2nd Period	3rd Period
infantry km to one rifle division	4-5	2.5-3	1.2-2.5
guns and mortars	20-80	120-220	200-300
tanks and SP guns	3-12	18-40	70-85
(tanks and SP guns in close support of infantry	(3-6)	(10-20)	(12-30)

* Tankovyy Udar, A. I. Radziyevskiy, p.40.

Table 56.* Scale of Front Offensive Operations in GPW.

Item	1st Period	2nd Period	3rd Period
Sector of advance (km)	300-400 upto 600	75-250	200-250
Depth of operation (km)	70-80	100-200	200-300
Average tempo of advance (km per 24 hrs)	4-5	10-20	20-30
Duration of operation (days)	14-20	10-20	12-20

* Ibid, p.41.

Appendix 2 to Annex B

Table 57. Massing of Forces and Weapons on the Main Axis in Army Operations of the Great Patriotic War*.

	Title and date of Operation	Army	Front-age (km)	Break-through sector (km)	Density on 1km of Break-through Sector on main axis				
					Rifle divs per km	arty above 76mm	tanks + SP guns		MBRL
							inf sp	in all	
1	Klin (Dec 41)	30A	80	-	7	10	1	1	1
2	Gzhat (Jan 42)	20A	20	8	1.5	44	9	12	5
3	Kharkov (May 42)	6A	80	18	3	38	7	25	1
4	Volkhov (Jul 42)	61A	80	10	2	76	11	33	15
5	Rzhev-Sichev (Aug 42)	31A	19	9	1.5	108	13	29	47
6	Volga counter-offensive (Nov 42)	5TA	35	14	3	68	12	27	4
7	Vol'khov (Jul 43)	11GA	36	14	1.3	185	21	46	10
8	Belgorod-Kharkov (Aug 43)	53A	7	7	1	154	11	41	7
9	Orsha (Jun 44)	11GA	35	16.5	1.1	181	22	46	35
10	Yassi-Kishinev (Aug 44)	37A	9	6	1.5	242	17	52	31
11	East Prussian (Jan 45)	25A	17	6	0.7	276	30	72	65
12	Visla-Oder (Jan 45)	69A	55	7	0.9	252	27	73	30
		56A	13	13	1.4	185	13	49	35
13	Berlin (Apr 45)	8GA	13	7	1.0	268	29	83	52
		3GA	28	9	1.6	215	11	50	20

* Savkin, op. cit., Table 4, p.283.

Appendix 3 to Annex B

Table 58. Scale of Army Offensive Operations from July 1943. *

	Operation and Date	Army	Width of Sector (km)			Operation depth (km)	Average rate of advance km/24hrs	Duration of operation in days
			at start of operation	breakthrough	at end of operation			
1	Orel Jul 43	11GA	36	16	100	60-70	9	7
2	Belorussian Jun 44	5A	22	12	60	150	18-20	8
		11GA	35	8	35	160	16-18	9
		49A	50	12	45	60	12	5
		3A	53	12	65	80	16	5
		65A	24	6	40	65	13	5
3	Lvov-Sandomir Jul 44	3GA	65	8	60	110	11	10
		60A	30	8	50	120	8-10	14
		38A	40	6	40	120	8-10	14
4	Yassi-Kishinev Aug 44	27A	22	8	40	50	16-17	3
		52A	30	8	60	60	20	3
		37A	9	6	40-50	120	17	7
5	East Prussian Jan 45	39A	45	8	20	55	8	7
		5A	9	9	18	80	6-7	12
		28A	20	7	25	75	6	13
		48A	15	6	30	85	14-15	6
		2SA	19	6	35	85	14-15	6
		65A	12	7	30	20	13	7
6	Visla-Oder Jan 45	5SA	12	6	25	140	23-24	6
		8GA	30	7	20	150	25	6
		69A	55	7	15	180	26	7
		13A	11	11	30	125	18	7
		52A	10	10	35	125	21	8
		5GA	13	13	55	130	22	6

* Armeyskiye Operatsii, A. I. Radziyevskiy, Table 2, p.10.

	Operation and Date	Army	Width of Sector (km)			Operation depth (km)	Average rate of advance km/24hrs	Duration of operation in days
			at start of operation	break-through	at end of operation			
7	Berlin	3SA	11	6	10-15	70	7	10
	Apr 45	5SA	9	7	12	70	7	10
		8GA	13	7	16	70	7	10
		3GA	28	9	48	50	7	7
		13A	10	10	64	56	14	4

Appendix 4 to Annex B

Table 59. Examples of Offensive Operations of Tank Armies - 1943-1945. *

Operations in which tank armies partici-pated	Armies	Constituent Formations	No of Tanks and SP Guns	Width of Sector in op depth (km)	Depth of adv (km)	Max rate of adv (km/ 24hr)	Max sepa-ration of army from front forces (km)
Orel	2 TA	3TC, 16TC, 11G INDEP TK BDE	371	15-25	115	8	15
	3GTA	12TC, 15TC, 2 MECH C, 91 INDEP TK BDE, 179 INDEP TK BDE	799	15-25	95	25	20
	4TA	5TC, 30TC, 11TC, 25TC	735	15-20	95	18	10
Belgorod-Khar'kov	1TA	6TC, 31TC, 3 MECH C	562	10-20	150	35	40
	5GTA	29TC, 18TC, 5G MECH C	350	10-25	120	28	25
Kiev	3GTA	5GTC, 7GTC, 9 MECH C, 91 INDEP TK BDE	621	upto 35	120	40	20
Zhitomir-Berdichev	1TA	11GTC, 8G MECH C, 31TC 64G INDEP TK BDE	546	upto 40	180	35	20
	3GTA	6GTC, 7GTC, 9 MECH C 91 INDEP TK BDE	c400	upto 40	180	35	20
Korsun-Shevchenko	5GTA	18TC, 20TC, 20GTC	236	16-20	75	40	50
	6TA	5GTC, 5 MECH C	204	10-15	80	40	-
Proskurov-Chernovits	1TA	11GTC, 9G MECH C 64G INDEP T BDE	549	15-35	250	30	15
	3GTA	6GTC, 7GTC, 9 MECH C 91 INDEP T BDE		upto 35	300	30	15
	4TA	10GTC, 6G MECH C 93 INDEP T BDE	253	15-25	300	25	10-15

* Tankovyy Udar, A. I. Radziyevskiy, Appendix 3, p.262.

Operations in which tank armies participated	Armies	Constituent Formations	No of Tanks and SP Guns	Width of Sector in op depth (km)	Depth of adv (km)	Max rate of adv (km/ 24hr)	Max separation of army from front forces (km)
Uman-Botoshan	2TA	16TC, 3TC, 11G INDEP TK BDE	231	20	250	65	30
	5GTA	18TC, 20TC, 29TC	196	upto 40	300	40	
	6TA	5GTC, 5 MECH C	153	upto 40	300	40	15-20
Vitebsk-Orsha	5GTA	29TC, 3GTC	562	upto 25	125	75	50
Minsk	5GTA	29TC, 3GTC	c500	30-40	130	60	60
L'vov-Sandomir	1GTA	11GTC, 8G MECH C 64G INDEP TK BDE	419	20-35	400	60	40
	3GTA	6GTC, 7GTC, 9 MECH C 91 INDEP TK BDE	490	upto 100	330	60	60
	4TA	10GTC, 6G MECH C	464	20-40	350	55	55
Lublin-Brest	2TA	16TC, 3TC, 8GTC	732	20	300	60	45
Yassi-Kishinev	6TA	5GTC, 5 MECH C	561	upto 35	300	65	70
Budapest	6GTA	5GTC, 9G MECH C	229	15-40	200	30	3-8
Visla-Oder	1GTA	11GTC, 8G MECH C, 64 INDEP TK BDE	792 (758)	upto 60	610	75	80
	2GTA	9GTC, 12 GTC, 1 MECH C	838 (856)	upto 40	705	90	90
	3GTA	6GTC, 7GTC, 9 MECH C 91 INDEP TK BDE	922	20-40	480	50	40-60
	4TA	10GTC, 6G MECH C	780	20	400	60	60
Vienna	6GTA	5GTC, 9G MECH C	360	15-25	320	25	5-15
East Prussian	5GTA	10TC, 29TC, 47 INDEP MECH BDE	585	15-30	250	50	30

Operations in which tank armies partici-pated	Armies	Constituent Formations	No of Tanks and SP Guns	Width of Sector in op depth (km)	Depth of adv (km)	Max rate of adv (km/ 24hr)	Max sepa-ration of army from front forces (km)
East Pomeranian	1GTA	11GTC, 8G MECH C, 11TC 64G INDEP TK BDE	584	upto 35	140	30	20
	2GTA	9GTC, 12GTC, 1 MECH C	276	10-15	140	40	60
Berlin	1GTA	11GTC, 8G MECH C, 11TC, 64G INDEP TK BDE	709	8-12	110	20	-
	2GTA	9GTC, 12GTC,1 MECH C	672	25	130	25	-
	3GTA	6GTC, 7GTC, 9 MECH C, 91 INDEP TK BDE	572	20	130	50	25-30
	4GTA	10GTC, 5G MECH C, 6G MECH C	395	15-30	170	50	25-30
Prague	3GTA	6GTC, 7GTC, 9 MECH C 91 INDEP T BDE	c400	10-20	180	90	100
	4GTA	10GTC, 6G MECH C, 5G MECH C	325	14-22	190	9	100
	6GTA	5GTC, 9G MECH C, 7 MECH C	c400	upto 25	180	60	70
Manchurian	6GTA	5GTC, 9G MECH C, 7 MECH C	1019	200	820	180	-

Key

G = Guards
T = Tank
Mech = Mechanised
C = Corps
GTC = Guards Tank Corps
Indep T Bde = Independent Tank Brigade
Mech C = Mechanised Corps

Appendix 5 to Annex B

Table 60. Density of Artillery on Breakthrough Sectors in Army Offensive Operations 1944-45.*

Operation and Date	Army	Width of break-through sector km	Average Density of Artillery on 1km of Breakthrough Sector			
			Mortars 82,120, 160mm	Guns Light 76mm G 122mmH	Guns Heavy & Super Heavy	Overall No. Guns/ Mortars
1944						
Oman (Mar)	27A	9	91	55	11	157
	52A	8	65	140	10	115
	4GA	8	80	158	12	150
Yassi-Kishinev (Aug)	27A	8	98	117	28	243
	52A	8	100	86	31	217
1945						
Visla-Oder (Jan)	5SA	6	113	132	28	273
	8GA	7	96	107	25	228
	69A	7	90	100	18	208
	33A	6	102	79	26	207
East Prussia (Jan)	5A	9	84	92	31	207
	38A	6	127	99	27	253
	28A	9	76	64	25	165
Berlin (Apr)	3SA	6	127	105	21	253
	5SA	7	123	113	38	274
	8GA	7	112	111	36	259

* Armeyskiye Operatsiy, A. I. Radziyevskiy, Table 7, p.40.

Appendix 6 to Annex B

Table 61. Distance and Time of Dispersion of Tank Armies in Areas Before Battle.*

	Operation	Army	Distance From Front Line km			Time Spent In Area	
			Conc Area	Assembly Area	FUP	Assembly Area - Days	FUP Hours
1.	Orel	4GTA	50	18-20	2-3	1	8
2.	Belgorod-Kharkov	5GTA	18-20	18-20	3	2	6
3.	Kiev	3GTA	20	20	6	1	13
4.	Lvov-Sandomir	1GTA	36-40	17-20	4-10	7	6
		3GTA	50-60	15-20	3-6	9	10-12
		4GTA	200-220	16-20	5	5	8-10
5.	Vitebsk-Orsha	5GTA	100	45-55	4-8	3	6-7
6.	Visla-Oder	1GTA	100-115	17-20	4-10	7	6
		2GTA	20-25	20-25	4-6	2	24
		3GTA	40-50	20	4	7	10-12
		4GTA	25	25	5	2	8
7.	Yassi-Kishenev	6GTA	80-90	18-20	3-4	1	6-8
8.	East Prussian	5GTA	130-160	15-30	behind front line	2	6-8
9.	East Pomeranian	2GTA	none	15	4-5	3	6-8
10.	Berlin	1GTA	40-50	46-50	10	-	18
		2GTA	46-50	15	2-3	1	8
		3GTA	20-30	20-30	none	2	12-20
		4GTA	20-30	20-30	4	2	11

* Tankovyy Udar, A. I. Radziyevskiy, Table 9, p.54.

Appendix 7 to Annex B

Table 62. Preparation Time for Tank Army Operations in GPW.*

	Operation	Army	Time of Preparation after receipt of order (days)
1.	Orel	2GTA	1
		3GTA	1
		4GTA	1
2.	Belgorod-Kharkov	1GTA	11
		5GTA	2.5
3.	Kiev	3GTA	7
4.	Zhidomir-Berdichev	1GTA	9
		3GTA	7
5.	Kirovograd	5GTA	3
6.	Korsun-Shevchenkov	5GTA	3
		6GTA	3
7.	Proskurov-Chernov	1GTA	3
		3GTA	6
		4GTA	3
8.	Uman-Botoshan	2GTA	5
		5GTA	5
		6GTA	6
9.	Vitebsk-Orsha	5GTA	3
10.	Lvov-Sandomir	1GTA	7
		3GTA	15
		4GTA	6
11.	Lublin-Brest	2GTA	4

* Tankovyy Udar, A. I. Radziyevskiy, Table 8, p.53.

	Operation	Army	Time of Preparation after receipt of order (days)
12.	Yassi-Kishenev	6GTA	9
13.	Visla-Oder	1GTA	42
		2GTA	42
		3GTA	34
		4GTA	43
14.	Budapest	6GTA	2
15.	Vienna	6GTA	5
16.	East Prussian	5GTA	5
17.	East Pomeranian	1GTA	6
		2GTA	16
18.	Berlin	1GTA	16
		2GTA	12
		3GTA	10
		4GTA	2 approx
19.	Prague	3GTA	2 approx
		4GTA	1 approx
20.	Manchurian	6GTA	34

Appendix 8 to Annex B

Table 63. Operational Density Of Soviet Forces At Beginning of the East Prussian Operation.*

Fronts and Armies	Across the whole Front			On breakthrough sector			Remark
	Length (km)	No of rifle divs	Km per 1 Rifle div	Length (km)	No of Rifle divs	Km per 1 Rifle div	
3rd Belorussian Front	170	54+1UR****	3.1	24	21**	1.1	
2nd Belorussian Front	285	63+3UR****	4.3	28	35***	0.8	
43A	95	13	7.3	-	-		
Totals	550	130+4UR****	4.1	52	56	0.9	

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* VIZH, 2.65, Table 3, p.82.

** Out of those 18 divisions were situated in the front line.

*** Out of those 27 divisions were situated in the front line.

**** UR - fortified area.

Table 64. Operational Density Of German Forces At Beginning of East Prussian Operation.*

Formation	Divisions					Width of Front (km)	Km per 1 div
	inf	tank	motor	light inf	total		
Army Group Centre							
3 Panzer Army	11	1	-	-	12	135	11.2
4 Army	11	1	2	1	15	28	18.6
2 Army	9	1	-	1	11	135	12.3
Res Gp Armies	1	-	2	-	3	-	-
Total	32	3	4	2	41	550	13.2 Average

* VIZH, 2.65, Table 5, p.83.

Appendix 9 to Annex B

Table 65. Operational Structuring of Fronts and Combined Arms Armies at the Beginning of the Visla-Oder Operation Jan/Feb 45.*

Front	First Echelon	Second Echelon	Mobile Group	Res-erve	Armies	Width of Front in km	Break-through sector km	Number of Formations			Mobile Groups
								First echelon	Second echelon	Res-erve	
1 Belo-Russian Front	47A	3SA	1GTA	7GCC	47A	14	4	RD-9			
	1A		2GTA		1A	53	-	{2 ** {CBDE 1	RD-3		
	61A		2GCC		61A	30	4	{RD-7 {UR-1		RD-2	
	5SA				5SA	12	6	RD-8		RD-1	
	8GA				8GA	30	7	RD-9		RD-1	
	69A				69A	54	7	RD-9		RD-1	11TC
	33A				33A	36	6	{RD-8 {UR-1		RD-1	9TC
Total Armies	7	1	2 TC Armies 1CC	1CC	7			RD-50	RD-3	RD-6	2TC
1 Ukraine Front	6A	59A	3GTA	7GMC	6A	94	-	{RD-4 {UR-1		RD-1	
	3GA	21A	4TA	1GCC	3GA	12	2	RD-3	RD-3	RD-3	25TC
	13A				13A	11	11	RD-6	RD-3		
	52A				52A	10	10	RD-6	RD-3		
	5GA				5GA	3	13	RD-9			{4GTC {31TC
	60A				60A	110	3	RD-6	RD-3		-
Total Armies	6	2	2T		6			RD-34	RD-12	RD-4	
Total	13	3	4T		13			RD-84	RD-15	RD-10	

* VIZH, 1.65, Table 9, p.76.

Key

A - Army
SA - Shock Army
GTA - Guards Tank Army
GCC - Guards Cavalry Corps
TC - Tank Corps
RD - Rifle Division
UR - Fortified Area

Appendix 10 to Annex B

Table 66. Operational Density of Artillery, Tanks/SP Guns and Infantry at the Beginning of the Visla-Oder Operation (a).*

Front	Width of front in km			Quantity of Guns and Mortars**			Arty Density per 1 km		Quantity of Tanks/SP Guns		
	Overall	Breakthrough sector	% of whole front	on whole front	Breakthrough sector	% to whole no.	Overall	Breakthrough sector	Overall	Breakthrough sector	% to whole no.
1 Belorussian Front	230	30***	13	13706	7318	53	60	244	3220	2942	91.3
1 Ukraine Front	250	36****	14.4	13717	8626	55.5	55	239	3244	3181	98

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* VIZH, 1.65, Table 7, p.75.

** Not including a/tk 45-57mm, rocket or AA artillery.

*** Excluding 4km breakthrough sector of 47A.

**** Excluding 3km breakthrough sector of 60A.

Table 67. Operational Densities for the Visla-Oder Operation (b).

Front	Density of tanks /SP Guns per km		Quantity of rifle divisions			Troop Density (km per rifle div)	
	Over-all	Break-through sector	on whole Front	Break-through sector	% to whole no.	Over-all	Break-through sector
1 Belo-russian Front	14	98	68	37	54	3.4	0.8
1 Ukrainian Front	13	88	66	34	51.5	3.08	1.06

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Table 68. Operational Structuring Of The Fronts At Commencement Of Berlin Operation - April 1945.*

Front	First echelon	Second echelon	Mobile Groups	Reserve	Totals			
					CAA	TA	Indep Corps	air army
2 Belo-russian Front	2SA 65A 70A 49A	none	1GTC 3GTC 8GTC 8MECHC 3GCC		4	-	5	1
1 Belo-russian Front	61A 47A 3SA 5SA 8GA 69A 33A 1 (Polish) Army	3A	1GTA 2GTA	7GCC	9	2	4	1*
1 Ukrainian Front**	3GA 5GA 13A 52A 2 (Polish) Army***	28A	3GTA 4GTA	1GCC	6	2	5	1

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* VIZH, 4.65, Table 3, p.81.

** Includes one air fleet.

*** 4GC, 25TC, 7G MECH C and 1 (Polish) TC in

KEY

CAA - Combined Arms Army
GTA - Guards Tank Army
GTC - Guards Tank Corps
GCC - Guards Cavalry Corps
MECHC - Mechanised Corps

Appendix 12 to Annex B

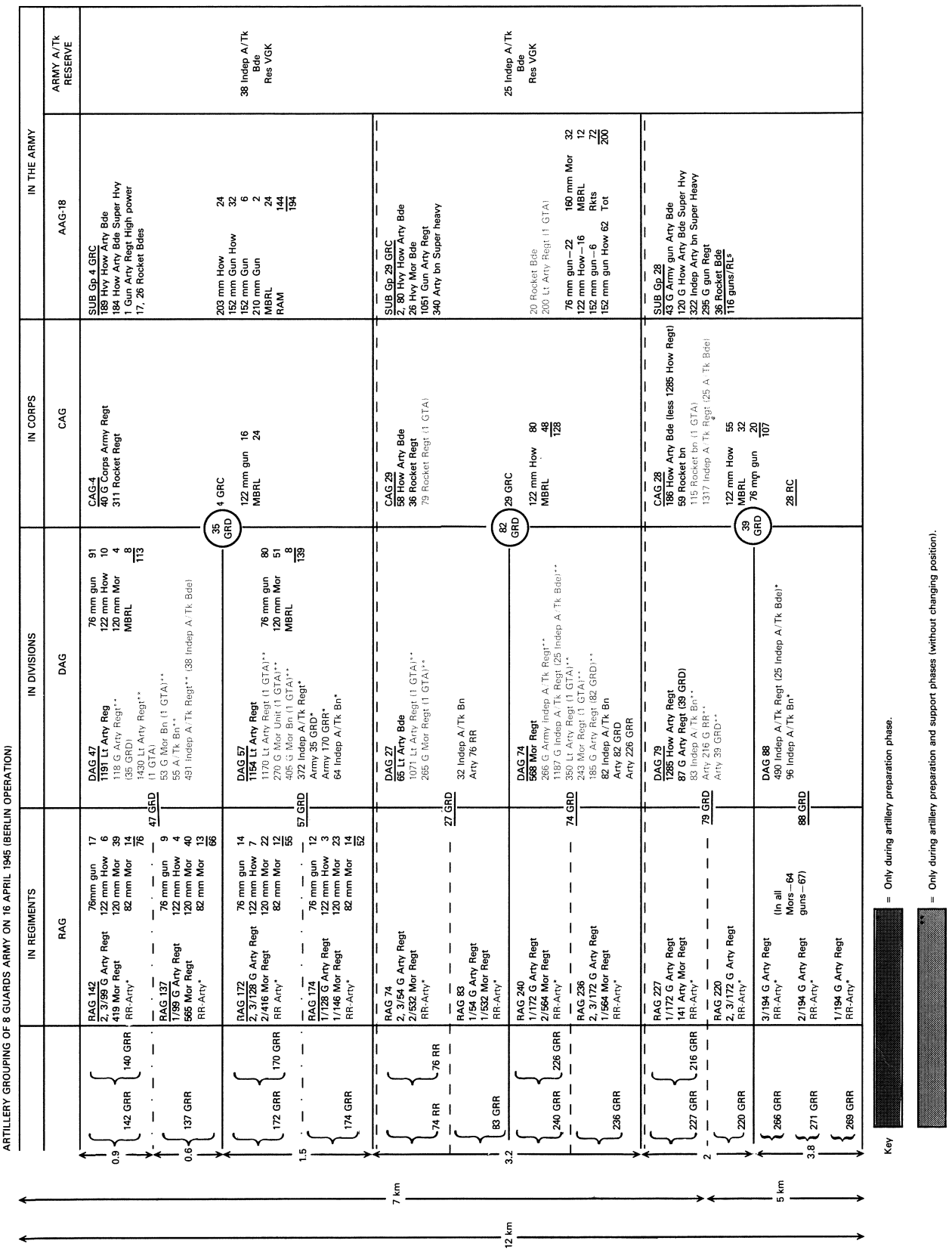

Figure 24. Artillery Grouping of 8 Guards Army on 16 April 1945 (Berlin Operation).

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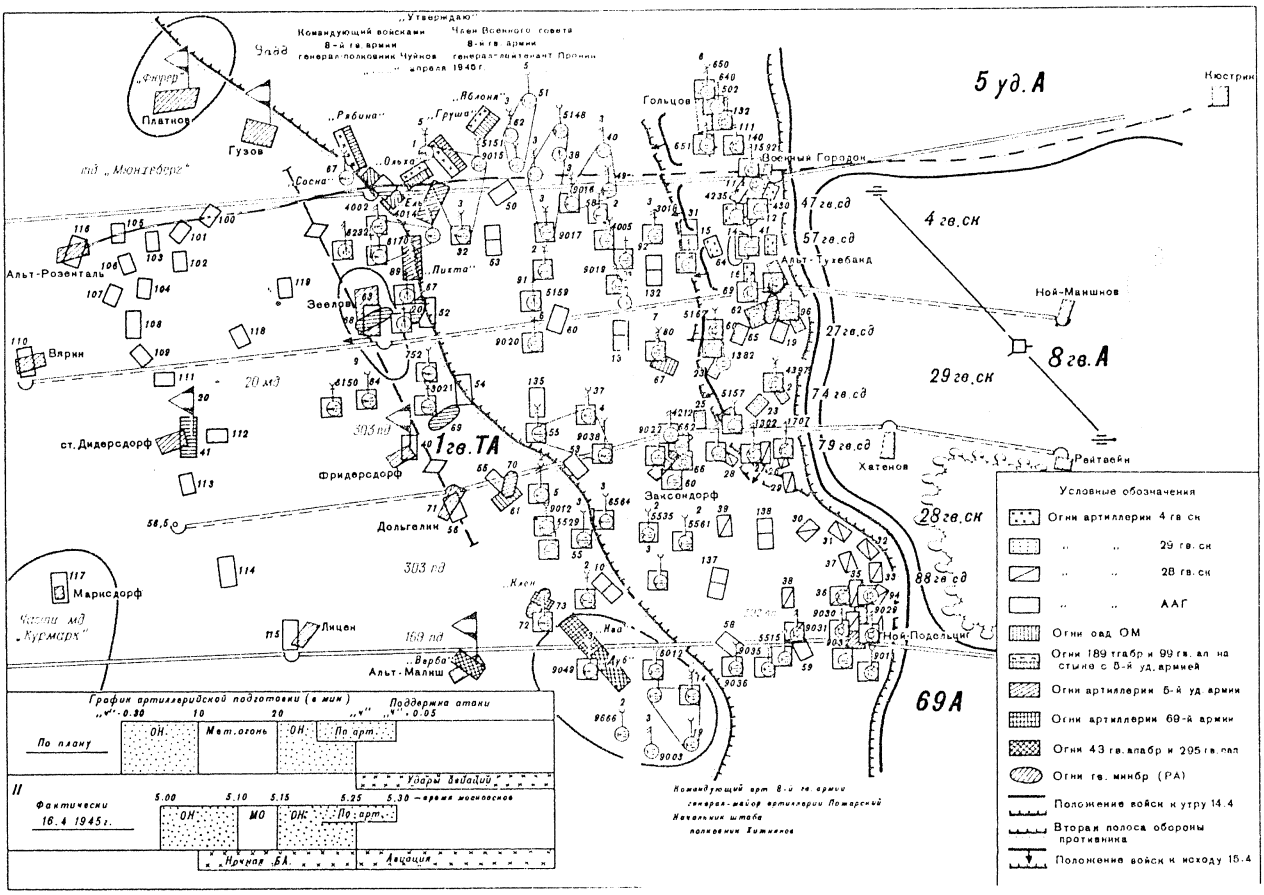

Figure 25. Copy of Sketch Map of Fireplan-8 Guards Army in Berlin Operation.

ANNEX C

STATISTICS OF NORMS OF SUPPLY AND EXPENDITURE.

Page

Details are contained in the Appendices below as follows:

Scale of Materiel Supplies in Front Line Units and the Operational Rear According to Pre-War Opinions	Appendix 1	(Tables 69-70)	464
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Appendix 1 to Annex C

Table 69. Scale of Materiel Supplies in Front Line Units and in the Operational Rear According to Pre-War Opinions.

Types of supplies, their echelonning and	Materiel		
	ammo BK	fuel (fills)	rations (24 hr)
Mobile (i.e. in Front line units)			
in rifle (cavalry) divisions	1.5	3.0	5
in tank (motorized) divisions	2.0	2.5	5
Previous balance (expendable) in Army depots/dumps			
a. in the advance	0.75-1.5	upto 2.0	upto 2-5
b. in defence	0.75-1.0	upto 1.0	3-4
in Front depots	8-10	upto 10	upto 30

Table 70. The Change in Depth of Rear Areas during the Course of the GPW.

	Periods	Depth of operational rear km			
		Front	Army	Div/Corps*	Overall
1.	According to prewar estimates	upto 500	75-175	50-75	650-750
2.	1941-1945. Theory.	150-250	75-100	20	200-370
3.	1941-1945. Practice (according to the experience of the most important operations)				
	a. in defence	150-250	100-150	30	310-400
	b. in the advance				
	- in preparation of operations	150-250	50-100	15-20	215-370
	- in the course of the operation	200-300	150-200	-	350-500

* Together with regimental rear area (8-12km).

Appendix 2 to Annex C

Rear of the Voronezh Front in the Belgorod-Khar'kov Operation - Provision of Materiel Resources July/August 1943.

Table 71.* & ** Ammunition Resupply as at 3 August 1943 (BK).

Type of Ammo	Army							
	1TA	5GTA	5GA	6GA	27A	38A	40A	47A
Mortar bombs all calibres	2.55	2.85	1.3	1.15	1.6	1.95	1.8	2.03
45mm	4.0	3.5	2.1	2.2	1.9	3.1	2.0	2.0
76mm	2.3	3.1	2.4	2.5	1.4	2.3	2.75	1.6
122mm	1.5	3.2	1.3	1.0	0.5	1.1	2.1	0.5
152mm	-	2.7	-	2.2	-	-	4.4	-

Besides the reserves of ammunition created in armies, front artillery depots held on average an additional 0.3 to 1.0BK reserve of ammunition. Guards Rocket Units had considerable supplies of rocket ammunition available, for example, on 3 August 1943 in units and dumps there were the following number of rocket projectiles in each fighting vehicle. Table 2 shows how these were allocated.

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* VIZH, 8.76, p.34.

** AA ammunition not included.

Table 72.

Type of Equipment MBRL	Number of Rockets
M-8	32
M-13	22.3
M-20	9.55
M-30	6.4
M-31	6.4

Table 73.* Fuel State as at 1800hrs 2 August 1943.

In "Fills" ("Zapravki").

Vehicle fuel	Diesel	Kerosene
3.1	7.4	19.9

Table 74. Voronezh Front Rations and Forage Available as at 3 August 1943 for the Belgorod-Khar'kov Operation measured in 'day's stocks'.*

Commodity	Availability			
	In Front line units	In Front Depots	Total in Front	In transit from depots and Central Bases
Bread/ Grain Gp	10.3	0.7	11.0	5.0
Maize Gp	7.0	0.6	7.6	6.0
Meat Gp	16.4	1.9	18.3	7.6
Oil/Fats Gp	13.3	2.3	15.6	13.0
Sugar Gp	21.9	1.1	23.0	12.0
Tobacco Gp	20.5	1.5	22.0	11.0
Forage Gp	24.3	7.7	32.0	3.0

* VIZH, 8.76, p.35.

Appendix 3 to Annex C

Operation "Bagration" (the Belorussian Operation) 22 June 1944 - Preparation Period May/June 1944.

During the preparation period for Operation "Bagration" (which was launched on 22 June 1944 and involved four fronts) the following scales of materiel supplies were amassed:

Table 75.* Wagon Loads of Supplies.

Fronts	Materiel in wagon loads				Additional Loads	Overall
	Ammo	Fuel	Food & Forage	Clothing		
1st Baltic	1682	2930	2765	193	622	8192
3rd Belorussian	3028	4634	2514	158	690	11024
2nd Belorussian	2024	2827	1817	99	489	7256
1st Belorussian	5777	6908	3389	285	1280	17639
Total wagon loads	12511	17299	10485	735	3081	44111

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* VIZH, 8.74, p.25.

Table 76.* Provision of Ammunition (BKs).

Type of Ammo	Distribution to Fronts (BKs)			
	1 Baltic	3 Belorussian	2 Belorussian	1 Belorussian
76mm PA	3.4	3.0	2.8	4.1
76mm DA	3.0	2.8	2.2	2.5
122mm Gun	5.0	3.0	2.6	3.8
122mm How	5.3	3.2	2.4	2.5
152mm How	6.1	8.3	4.3	7.7
152mm Gun/How	5.1	3.4	2.2	3.8
82mm	4.1	2.6	3.1	2.8
120mm Mor	5.4	3.9	2.6	3.3

Some 60-80% of all rounds of heavier calibre were concentrated with 1st echelon divisions. Approximately 2BK of ammunition were predumped on the ground at artillery gun positions.

Table 77.** Provision of Fuel.

Fuel in Fills	Fronts			
	1 Baltic	3 Belorussian	2 Belorussian	1 Belorussian
Petrol	4.1	3.4	2.5	4.1
Diesel	7.6	6.3	6.4	7.1
Aviation fuel	9.2	6.2	10.2	4.0

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* VIZH, 8.74, p.25.

** VIZH, 6.74, p.26.

Table 78.* Provision of Rations.

Days	
front line troops	Army depots
7-10 days	5-7 days

Table 79.** Railway Wagon Loads Despatched to the Fronts June to August 1944 after Commencement of the Offensive on 22 June.

Fronts	Materiel supplies (wagons loads)					
	Ammo	Fuel	Rations/Forage	Clothing	Additional	Total
1 Baltic	2645	6251	2956	65	477	12394
3 Belorussian	2484	5845	3059	114	604	12106
2 Belorussian	1802	4139	1799	234	288	8262
1 Belorussian	2934	8747	2859	151	827	15518
Wagon loads overall	9865	24982	24982	564	2196	48280

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* VIZH, 8.74, p.26.

** VIZH, 8.74, p.27.

Appendix 4 to Annex C

Table 80.* Amassing of Materiel at Start of Visla-Oder Operation.

Fronts	Categories of Materiel Resources								
	Ammo Bks		Fuel Fills			Rations			
	Inf Wpns	Arty	Avn	Petrol	Diesel	Grain	Groats	Fat	Sugar
1 Belorussian	1.5/2.5	3.1/9.8	14.1	4.3	3.4	140	65	33	66
1 Ukraine	1.5/2	3.5/4	9.4	5.1	4.6	21.7	20	28.8	36

Table 81.** Stockpiled Supplies at the Start of the Berlin Operation in April 1945.

Fronts	Artillery Ammunition Bks					Fuel Fills		
	76-100mm	122mm	152-203mm	AA Arty	Mors	Avn	Petrol	Diesel
2 Belorussian	1.8	1.25	2.2	2.8	1.2	6.8	3.1	5.2
1 Belorussian	2.9	3.0	3.0	3.0	4.25	8.7	5.8	5.5
1 Ukraine	1.85	2.7	2.95	2.75	2.0	6.5	4.7	5.0
Average	2.18	2.32	2.6	2.85	2.48	7.3	4.53	5.23

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* VIZH, 1.65, Table 5, p.73.

** VIZH, 4.65, Table 2, p.84.

Appendix 5 to Annex C

Table 82. Ammunition Expenditure in Offensive Operations of Tank Armies. *

	Operations	Armies	Ammo Expenditure (BK)						Remarks
			Rifle Ammo	MG Ammo	82mm Mor	120mm Mor	76mm Arty	76-85mm Tank	
1	Belgorod-Kharkov	1TA	0.35	0.7	1.74	1.93	0.43	1.7	
2	Korsun-Shevchenko	2TA	1.2	1.0	1.4	1.0	1.6	0.8	
3	Lvov-Sandomir	4TA	0.8	1.0	1.9	2.5	1.0	0.9	
4	Lublin-Brest	2TA	0.95	1.1	1.1	1.1	1.1	1.4	
5	Visla-Oder	1GTA	0.5	0.6	0.6	0.4	0.5	0.7	
		2GTA	0.5	0.6	0.2	0.5	0.4	0.65	
		3GTA	0.6	0.8	0.6	2.5	1.4	1.5	
		4TA	0.54	1.25	0.57	1.11	1.22	0.59	
6	Berlin	1GTA	0.38	0.98	1.26	3.7	1.64	1.9	
		2GTA	0.7	0.8	0.8	2.1	1.55	1.9	
		3GTA	0.64	0.62	1.3	1.7	0.85	1.06	

* Tankovyy Udar, A. I. Radziyevskiy, Table 22, p.231.

Appendix 6 to Annex C

Table 83. Fuel Consumption by Tank Armies in Offensive Operations.*

	Operation	Armies	Diesel		Petrol		Aviation Fuel KB-70		Selected Totals		Remarks
			Tons	Fills	Tons	Fills	Tons	Fills	Tons	Fills	
1.	Orel	2TA	232	2.9	656	5.0	112	4.3			
		3GTA	1100	3.7	2224	9.6	190	6.4			
		4TA	458	2.5	1568	4.3	113	2.8			
2.	Belgorod -Kharkov	1TA	561	3.6	2071	9.8	329	6.8	2961	20.2	See Ser 1 Appendix 7
3.	Kiev	3GTA	459	2.4	1014	3.6	101	3.5			
4.	Korsun-Shevchenkov	5GTA	500	2.2	850	2.4	39	2.4			
5.	Proskurov-Chernovit	1TA	500	3.3	1090	5.0	75	3.6			
6.	Lvov-Sandomir	1GTA	1720	7.5	3090	11.2	235	5.7	5045	24.4	See Ser 2 Appendix 7
		3GTA	1435	8.6	3077	10.2	303	7.7			
		4TA	960	7	2467	8.6	301	9.8			
7.	Lublin-Brest	2TA	948	3.5	1915	5.3	152	4.2	3015	13.0	See Ser 3 Appendix 7
8.	Visla-Oder	1GTA	1175	3.9	2535	6.5	382	6			
		2GTA	885	3	2182	4.0	218	4.5	3285	11.5	See Ser 5 Appendix 7
		3GTA	1920	6	3519	7.6	392	6.7			
		4TA	1214	4.7	1739	6.7	249	4.1			
9.	East Prussian	5GTA	857	3.4	1951	5.9	209	4.5			

* Tankovyy Udar, A. I. Radziyevskiy, Table 28, p.232.

	Operation	Armies	Diesel		Petrol		Aviation Fuel KB-70		Selected Totals		Remarks
			Tons	Fills	Tons	Fills	Tons	Fills	Tons	Fills	
10	East	1GTA	408	1.7	984	2.6	98	2.0			
	Pomeranian	2GTA	470	2.3	1834	3.6	107	2.5			
11	Berlin	1GTA	525	2.7	1192	3.2	148	3.5	1865	9.4	See Ser 6
	2GTA		800	4.1	2149	4.8	157	4.0	3106	12.9	Appendix 7
	3GTA		654	2.6	1746	3.9	147	3.5	2547	10.9	
	4GTA		458	2.5	1568	4.3	113	2.8			

Appendix 7 to Annex C

Table 84. Captured Fuel as a Percentage of Fuel Consumed by Tank Armies in Offensive Operations (in tonnes).*

	Operation	Army	Overall Fuel Consumption (tonnes)	Incl Captured Fuel	Captured Fuel as a % of Total Consumption
1.	Belgorod-Kharkov	1TA	2961	962	23
2.	Lvov-Sandomir	1TA	5045	94	1.8
3.	Lublin-Brest	2TA	3015	921	30.5
4.	Yassi-Kishinev	6TA	1800	1288	71.5
5.	Visla-Oder	2GTA	3285	822	25
6.	Berlin	1GTA	1865	840	45.4
		2GTA	3106	568	18
		3GTA	2547	386	15.8

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* Tankoviy Udar, A. I. Radzievskiy, Table 31, p.237.

ANNEX D

NORMS OF ARTILLERY FIRE AND EXPENDITURE.

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Appendix 1 to Annex D

Methods of Fire/Engagement of Targets.

The definitions of the various methods of fire employed by Soviet artillery are shown below.

Fire on an individual target (ogon' po otdel'noy tseli). Fire of a battery, troop or gun which is carried out independently by indirect or direct fire.

Defensive Fire (zagraditel'nii Ogon'). A continuous fire curtain which is either static, i.e. located on one target (NZO - ne podvizhnii-zagraditel'nii ogon') or successive, i.e. on several features in succession (PZO - posledovatel'nii zagraditel'nh ogon').

When firing at, for example, a NATO tank platoon of five tanks advancing in column towards the FEBA, the depth of the troop column is 150-200m. It moves at 12-15kph (200-250 m/min), covering a distance (150-200m) in approximately 1 minute. Within this time a 122mm Soviet howitzer detachment can fire 6 rounds, a 152mm howitzer detachment 4 rounds. When they come under fire, the speed of the attacking tanks may decrease, therefore the length of time to engage these tanks may be increased to 1.5 minutes. Given this time the possible ammunition expenditure on each line of the defensive barrage may be: 122mm howitzer up to 9 rounds, 152mm howitzer up to 6 rounds, i.e. an overall average of 0.1BK. Such a rate of expenditure may be used in the calculation determining the artillery battalion's fire capabilities and the amount of ammunition needed for carrying out the assigned fire missions.

Concentration of Fire (Sosredotochenniy Ogon') (SO) - Fire which is carried out simultaneously by several batteries (divisions) on one target or line.

Successive Concentrations of Fire (Posledovatel'noye Sosredotocheniye Oghnya) (PSO) - single, double or treble. PSO are used for the support of an attack or counter-attack by MR or tank sub-units by concentrations of fire successively switched from forward targets to targets in the depths of the enemy position. This is the main method of suppressing a modern anti-tank defensive position.

Barrage. Barrages (single or double) are used to support an attack when the enemy defence has a dense set of trenches making it difficult to determine the exact position of strongpoints. They are also used in the breakthrough of a fortified area. The barrage is a continuous fire curtain which is successively switched from line to line immediately in front of the attacking sub-units.

Rolling barrage:	A continuous curtain of fire laid on successive (ognevoy val) predetermined lines at specified intervals in advance of attacking troops and on the axis of their advance.
Double rolling barrage: (dvoynoy ognevoy val)	As above, but laid on two lines simultaneously, moving by leapfrog.
Heavy burst of aimed fire: (ognevoy nalet)	A surprise, high density salvo followed by a steady bombardment during which the predetermined quantity of ammunition is fired over a fixed time period.
Fire strike: (ognevoy udar)	Concentrated, massed fire of high density for a relatively short period of time, and on a very large scale.
Riccochet fire: (rikoshetnaya strel'ba)	Shells impacting at angles of 2 to 25 degrees with a delayed fuze setting, timed so that the shell bounces and burst at 3-4m height, giving maximum shrapnel beaten zone.
Direct fire: (pryamoy navodkoy)	All modern Soviet field guns and howitzers are equipped for direct fire and carry shaped charged projectiles. A very high proportion of artillery support to an offensive will be by direct fire. "Direct fire" by mortars means that the target is in view of the weapon.
Running fire:	A series of volleys.

Harrassing fire: (ognevoye nablyudeniye)	Shells landed sporadically - approx 1 per minute per hectare - on the target to prevent troop movement in the open and lower the morale of the enemy.
Fire ambush: (kinzhalnyy ogon')	A surprise, dense and rapid burst of direct fire from close range from any type of weapon, including small arms.

In the course of the artillery support of the attack (counter-attack) and the 'in-depth' battle the safe distance of shells from own troops on average is:

tube artillery	- MR sub-units attacking on foot	- 400m
	- MR sub-units attacking in BMP	- 300m
	- tank sub-units	- 200m
rocket artillery	- all troops	- 1000m.

Appendix 2 to Annex D

ARTILLERY BOMBARDMENT PHASES IN ATTACK AND DEFENCE.

Attack

Artillery bombardment of the enemy can be divided into three phases.

The artillery preparation of the attack, carried out immediately before the attack.

The artillery support phase, as soon as the first echelon of the attack moves forward and continues until the defenders' first echelon is captured. The switch from the preparatory to the support phase must not be obvious, or else it will warn the defender of the impending attack.

The artillery accompaniment of the troops in depth involves the guns moving forward with the attack to maintain a continuous bombardment of the defender as the advance develops into the depths of the defence. It may also include the support of the commitment of the attackers second echelon and repulse of defenders counter-attack.

Defence

Artillery interdiction of the enemy advance involves planned fire on key points on likely enemy approaches, especially where the attacker would deploy into battle formations.

Artillery repulse of the enemy attack, by concentrated fire, on moveable and fixed lines to break up the attackers battle formation and separate the infantry from the tanks.

In artillery support for defence in depth, artillery will engage infiltrating attackers by concentrated fire and by fire on single targets preventing them penetrating further into the depths of the defence.

Engagement of the enemy during the counter-attack by the defending

forces falls under the categories of preparation and support as in a normal advance.

EXTRACTS FROM FIRE PLANS.

Extracts from fire plans at Regimental Artillery Group (RAG) and artillery battalion level.

Attack.

Extract from Regimental Artillery Group 10 (RAG 10) fire plan in support of an attack by 2/10 MRR (2nd Battalion of 10 Motor Rifle Regiment) to Commander 2/20 Artillery Regiment, (2 Arty Bn of 20 Arty Regt)	Enclosure 1 (Figure 26)
Extract from 2/20 Artillery Regiment fire plan to Commander RAG 10, showing allocation of tasks to the artillery battalion three batteries, together with a map showing artillery battalion tasks in support of an attack by the MRR second echelon.	Enclosure 2 (Figure 27)

Defence.

Fire capabilities of artillery battalion	Enclosure 3 (Table 85)
Extract of 1/2 Arty Bn Fire plan of RAG 4 with ammunition allocation for each phase	Enclosure 4 (Figure 28)
Working map of CO 1/2 Artillery Regiment	Enclosure 5 (Figure 29)
Map of artillery preparation and support of counter-attack	Enclosure 6 (Figure 30)
Working map of artillery support by 2/20 Arty Regt	Enclosure 7 (Figure 31)
Plan of Operation - Roving Troop 1/2 Artillery Battalion in Defence	Enclosure 8 (Figure 32)

Enclosure 1 to
Appendix 2 to Annex D

	Operation of all arms sub-units	Periods of Engagement	Battalion task - duration and methods of engagement	Code words to begin fire	FMs for 2/20 Arty Regt
1.	Move forward. H-47 sub-units commence deploying into bn column	Artillery Preparation for attack H-47 to H-7	H-47 to H-44 (FM - 3 mins) Neutralise Mor tp	"STORM" series of red rockets	target no. 79. 220 rounds
	Successive deployments into coy and tp columns		H-44 to H-31 (FM - 13 mins) Neutralise strong-points in enemy front line	LIGHTNING	target no. 112. 440 rounds
			H-31 to H-17 (FM - 14 mins) Neutralise personnel and weapons in depth	HAIL	target no. 53. 550 rounds
			H-31 to H-27 Neutralise Mor tp		target no. 79. 70 rounds
	Deployment into battle order onto start line into attack	Artillery Preparation H-47 to H-7	H-17 to H-7 Neutralise enemy strongpoint on enemy FEBA	'ADVENTURE'	target no. 112. 360 rounds
			H-9 to H-3	'RAIN'	target no. 79. 160

Figure 26. Fireplan - RAG 10. Extract from RAG 10 in Attack CP - Wood (3597) 17.7.84 - 1200 Map 50,000 - 1978.*

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* Artilleriyskiy Divizion v Boyu, G. E. Peredel'skii, Table 8, p.86.

	Operation of all arms sub-units	Periods of Engagement	Divisions task - duration and methods of engagement	Signals for com mencement	FMs for 2/20 Arty Regt
			Neutralise Mor tp		rounds
2.	H-7 Cross over into attack until H +60 when defeat of enemy first echelon bns is complete	Artillery support for the attack	Support of attack by successive concentrations: 1st line (3 mins) 2nd line (6 mins)	'LION' 'TIGER'	tgt no.112 100 rounds tgt no.224 96 rounds
3.	Beat off enemy counter-attack from axis X rds height 84.2		Neutralise move forward of enemy reserves on call for targets		targets 54, 55 DF 'A'
	Second echelon regt committed to battle to develop success axis 'STONE' height 96.7	ARTY ACCOMPANI-MENT OF THE ATTACK/ ADVANCE IN DEPTH	10mm FM neutralise personnel/weapons neutralise located artillery and Mor btys	SNOW	targets 63, 108
	From the march attack by enemy brigade reserve positions		Neutralise - pers/ wpns on enemy bde reserve position on call for targets		target 64
	Beat off counter-attack by enemy divisional reserve from axis height 96.7 LAKE 'HORS		Neutralise move forward enemy reserves repel counter-attack on call for targets		targets 74, 75 DF LYNX 1 LYNX 2
	Signals		ammunition - 2.45BK a. arty prep 1.25BK b. arty support 0.3 BK	(total) broken down into;	

	Operation of all arms sub-units	Periods of Engagement	Divisions task - duration and methods of engagement	Signals for com mencement	FMs for 2/20 Arty Regt
			c. arty accomp-animent of troops in depth } 0.9 BK		

Enclosure 2 to
Appendix 2 to Annex D

Operations of Mechanised Units	Period of Engagement	Division tasks duration and method of engagement	Signals for commencement	Fire missions Tgt no - ammo norms		
				4 Bty	5 Bty	6Bty
Move fwd to FUP	Artillery Preparatory Phase	H-47 to H-44 (FM - 3 mins)	'STORM' series of green	tgt 79 72	tgt 79 72	tgt 79 72
at H-47 begin deployment into bn columns	H-47 to H-7	Neutralise enemy Mor tp	rockets			
		H-44 to H-31 (FM - 13 mins)	LIGHTNING	tgt 112 144	tgt 112 144	tgt 112 144
successive deployment into coy and pln columns		Neutralise pers/wpns in enemy strongpoint on enemy FEBA				
		H-31 to H-17 (FM - 14 mins)	HAIL	tgt 53 216	tgt 53 108	tgt 53 216
		Neutralise pers/wpns in enemy strongpoint in depth				
		H-31 to H-27 (FM - 4 mins)		tgt 79 72		
		Neutralise enemy Mor tp				

Figure 27. Extract from Fire Plan - 2/20 Artillery Regiment in Attack. *

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* Artilleriyskiy Divizion v Boyu, G. E. Peredel'skiy, Table 10, p.90.

Operations of Mechanised Units	Period of Engagement	Division tasks duration and method of engagement	Signals for commencement	Fire missions Tgt no - ammo norms		
				4 Bty	5 Bty	6Bty
Deployments into battle formation and move forward onto SL for attack		H-17 to H-7 (FM - 10 mins) Neutralise pers/wpns in enemy strongpoint on FEBA	ADVANTAGE	tgt 112 144	tgt 112 72	tgt 112 144
		H-9 to H-13	RAIN		tgt 79 162	
At H-07 cross over into attack attack and at H-60 complete destruction of enemy first echelon bn		Support attack by successive concentration of file with fire on:				
		1st bound (4 mins)	LION	tgt 112 72	-	tgt 112 36
		2nd bound (6 mins)	TIGER	tgt 224 36	-	tgt 224 72
Second echelon bn - 6 MR Coy brought into battle to develop success from bound	Artillery Accompaniment in depth phase	Neutralise pers/wpns in front of 2nd ech- Start line prep to fire on target				
Bridge-Kurtarnik (3m as N g lapse NIZKAYA) on axis Bridge-Lake Hor'		By concentration and defensive fire repel enemy counter-attack Prep to fire on		43	43	43
Beat off enemy brigade reserves				54, 55 DF ACACIA	54, 55 DF ACACIA	54, 55 DF ACACIA
Regt 2nd echelon - 1 MR bn brought into battle to develop success from SL		(FM - 10 mins) Neutralise pers/wpns in front of start line	SNOW	63 36	63 36	63 36

Operations of Mechanised Units	Period of Engagement	Division tasks duration and method of engagement	Signals for commencement	Fire missions Tgt no - ammo norms		
				4 Bty	5 Bty	6Bty
Horse-copse TENNKY on axis Kamin H-96.7		Neutralise btys/mor tp				
Mass the mive seize enemy reserve position		Neutralise enemy bde and positions		64	64	64
Repel counter-attack of div reserves on axis H-96.7 and Lake Hor'		By concentration and defencsive fire repel counter-attack		74, 75 Moving DF RICE DF BEREZA	74, 75 Moving DF RICE DF BEREZA	74, 75 Moving DF RICE DF BEREZA

Ammo norm - 2.45BK consisting of:

- Arty Preparation Phase - 1.25BK
- Arty Support Phase - 0.3BK
- Arty Support In Depth - 0.9B

Enclosure 3 to
Appendix 2 to Annex D

Table 85. Fire Capabilities of 1/2 Artillery Regiment in Defence (14 x 122mm How).*

Task	Ammo Allocation BK/Rounds	Fire Capabilities (neutralisation)
Arty interdiction of move forward and deployment of enemy forces	0.4 32 x 14 = 448	columns motor inf coy x 2 conc - 240rds Mor Tp x 1 conc - 220rds
Repulsing enemy attack	0.6 48 x 14 = 672	2/3 lines PZO - 330rds 2 sectors NZO - 220 rds 2/3 single tgts - 120rds
Artillery SP of defence in depth	0.6 48 x 14 = 672	motor inf in battle fmn - 2 coys conc - 220rds 2 sectors NZO - 220rds 4/6 single tgts - 230rds
Bombardment of enemy during counter-attack	0.4 32 x 14 = 448	motor inf in battle fmn - 2 coys conc - 220rds 4/6 single tgts - 200rds

The fire missions given to the battalion to be finalised on the ground.

Preparation of the battalions to be effected in the agreed time and space programme.

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* Artilleriyskiy Divizion v Boyu, G. E. Peredelskiy, Table 18, p.176.

Enclosure 4 to
Appendix 2 to Annex D

Actions of combined all arms sub-units	Tasks (phases of arty engagement of enemy)	Tasks of Arty Bn and methods of execution	Signal to open fire	Fire missions and tgt nos.		
				1 Bty	2 Bty	3 Bty
Defence of occupied posns and strongpoints	Arty interdiction of enemy move forward and deployment	Fire missions to engage columns moving fwd and deploying in readiness		Conc tgts 40,41, 42,43	Conc tgts 40,41, 42,43	Conc tgts 40,41, 42,43
Defence of occupied posns and strongpoints. Fire from all categories of wpns to repel enemy attack	Arty repulse enemy attack	Conc defensive fire and fire on single tgts on attacking enemy in front FEBA /on FLOT. In the battle for the first posns. In In readiness.		PZO: 'LION'1&2 'TIGER' 1&2&3 NZO: 'AKATSIA' 'BEREZA' 'VISHNIYA' tgts 19,51	PZO: 'LION'1&2 TIGER 1&2&3 NZO: AKATSIA BEREZA VISHNIYA	PZO: 'LION'1&2 TIGER 1&2&3 NZO AKATSIA BEREZA VISHNIYA tgts 20,54
By fire all means and of strong defence to prevent	Arty support of defence in depth			Conc tgts 62,63 NZO: KLEN TOPOL' tgt 35	Conc tgts 62,63 NZO: KLEN TOPOL'	Conc tgts 62,63 NZO: KLEN TOPOL'

Actions of combined all arms sub-units	Tasks (phases of arty engagement of enemy)	Tasks of Arty Bn and methods of execution	Signal to open fire	Fire missions and tgt nos.		
				1 Bty	2 Bty	3 Bty
2nd MRR - 3 MR bn with tk coy move fwd for counter-attack 1st ech sub-units contain battle in holding defence positions 2nd ech counter-attack	ARTY PREP	Conc arty fire to cover move fwd of 2nd ech to SL.				
	Arty securing move fwd of troops.					
	Arty prep for counter-attack.	8 mins fire plan to prepare for counter-attack 2nd ech.	'URAGAN'	Conc tgts 61,62	Conc tgts 61,62	Conc tgts 61,62
	Arty support of counter-attack	Conc arty fire and on single tgts in support of counter-attack		Conc tgt 54	Conc tgt 54	Conc tgt 54

Signals	Ammo Expenditure 2.0BK consisting of:	
Call for fire - series of green rkts	Arty interdiction of en move fwd and deployment	0.4BK
Ceasefire - 'stop' series of red rkts	Arty repulsing of enemy attack	0.6BK
Own tps - series of white rkts	Arty support of defenders in depth	0.6BK
Appendix: co-ordinated of tgts as in Table 9.	Arty support of counter-attack	0.4BK
		2.0BK

Figure 28. Defence Fire Plan 1/2 Artillery Battalion of RAG 4. Fire Control Centre detached house (4321) 5 Sept 84 1630hrs. Map 50,000, Printed in 1978.*

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* Artilleriyskiy Divizion v Boyu, G. E. Peredelskiy, Table 19, p.181.

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Appendix 2 to Annex D

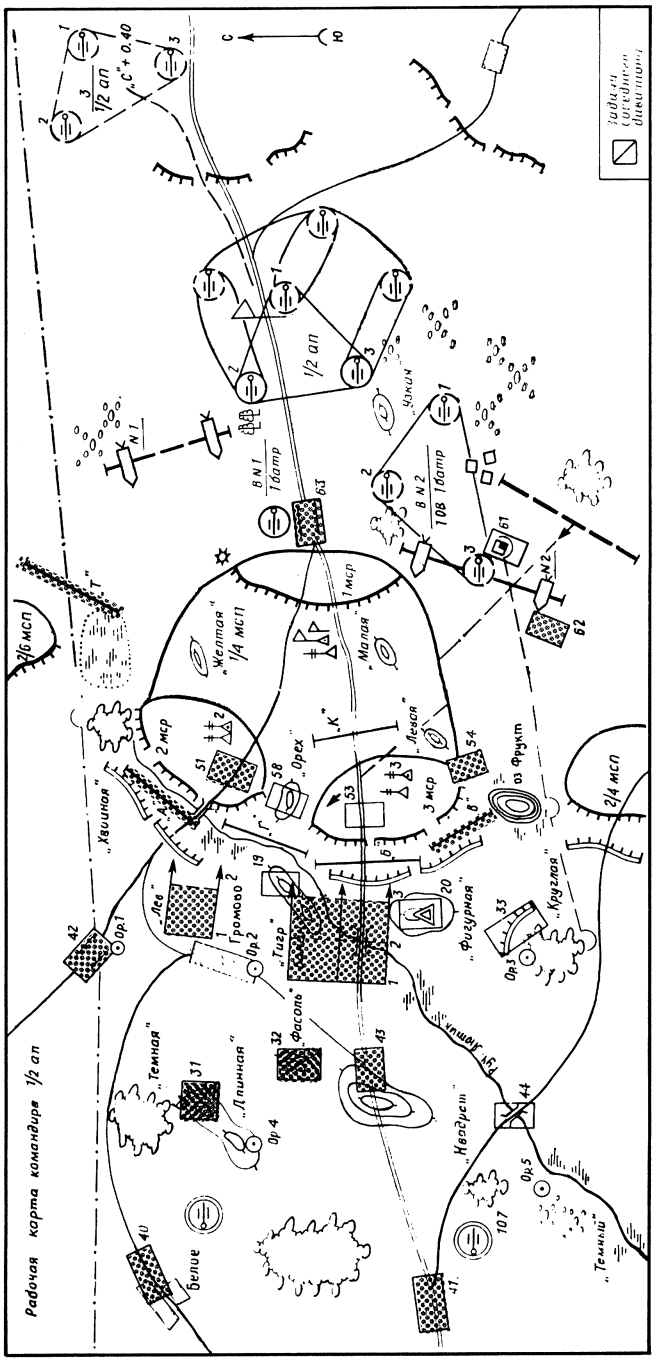
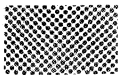


Figure 29. Working Map of CO 1/2 Artillery Regiment.

Key to Figure 29.

Artillery Battalion Tasks.

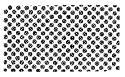
1. Artillery interdiction of the move forward and deployment of enemy troops. Ready to carry out concentration on targets 40, 41, 42 and 43.



2. Artillery repulse of the enemy attack. Ready to carry out:

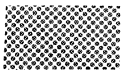
P20 LION 1 and 2, TIGER 1, 2 and 3

N20 AKATSIYA, VISNIA ('A' and 'B')



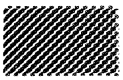
Concentrations on targets 51 and 54.

3. Artillery support of defence of troops in depth of defence. Ready to engage on targets 62, 63 and N20 to POL (T).



4. Engagement of enemy in delivery of counter-attack by second echelon. 4 MR Coy - (phases preparation and support of attack) - targets 61, 62 and 54.

5. Tasks of neighbouring artillery division (battalion) targets 31 and 32.



Enclosure 6 to
Appendix 2 to Annex D

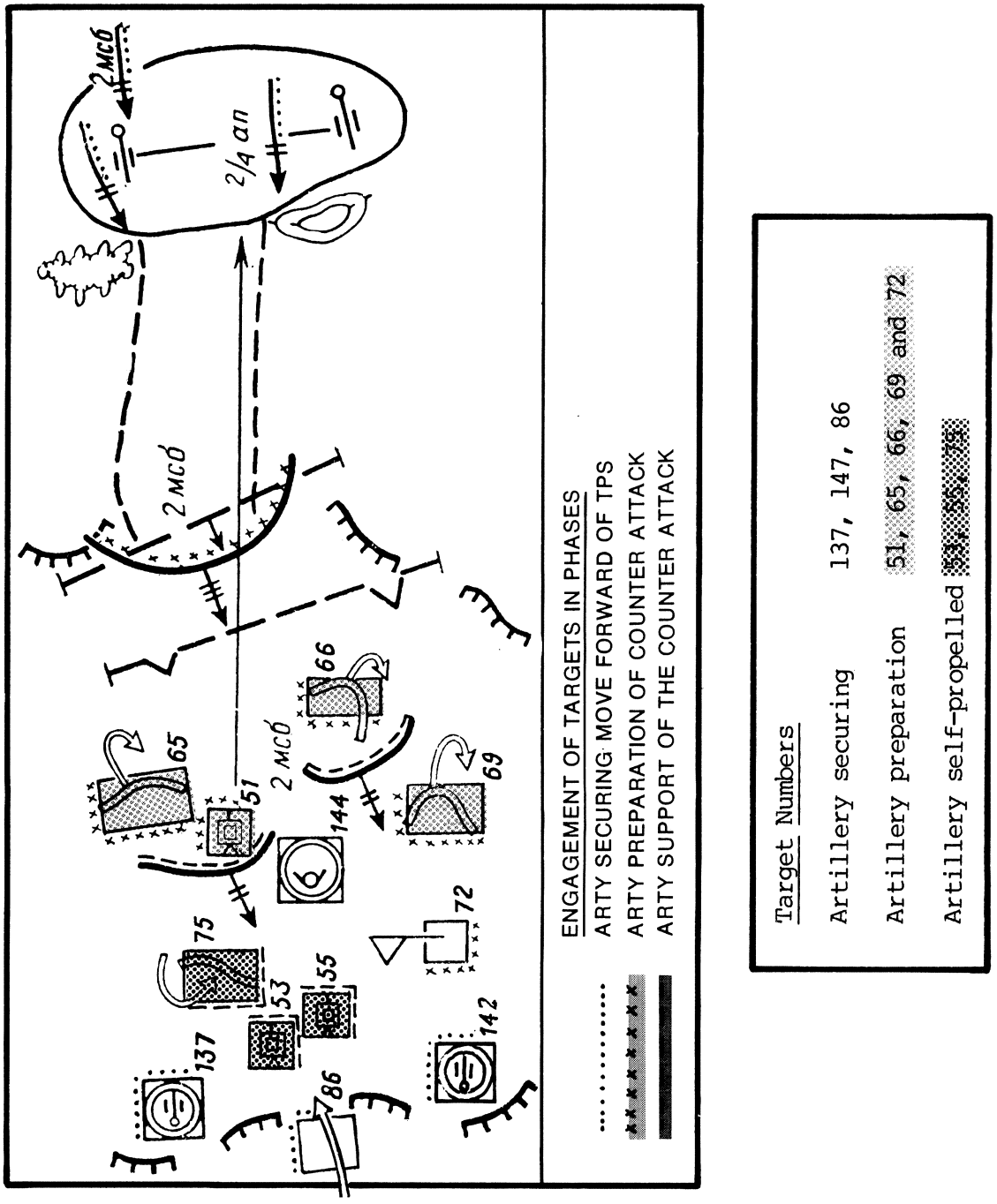


Figure 30. Map of Artillery Preparation and Support of Counter-Attack.

In the artillery support of the counter-attack, the battalion destroys and neutralizes personnel and weapons on the counter-attack axis and flanks. In this as a result it uses concentrated fire and fire on single targets.

After the execution of the counter-attack and restoration of the situation the battalion carries out fire missions to consolidate the captured feature.

In the preparation of fire in defence, character of the ground, likely enemy operations and the fire capabilities of the artillery sub-units are taken into account. Fire is prepared both on known reconnoitred targets and on the expected (assumed) location of enemy appearances. Preparatory fire is finalised on the degree of new data reconnoitred from the enemy.

Enclosure 7 to
Appendix 2 to Annex D

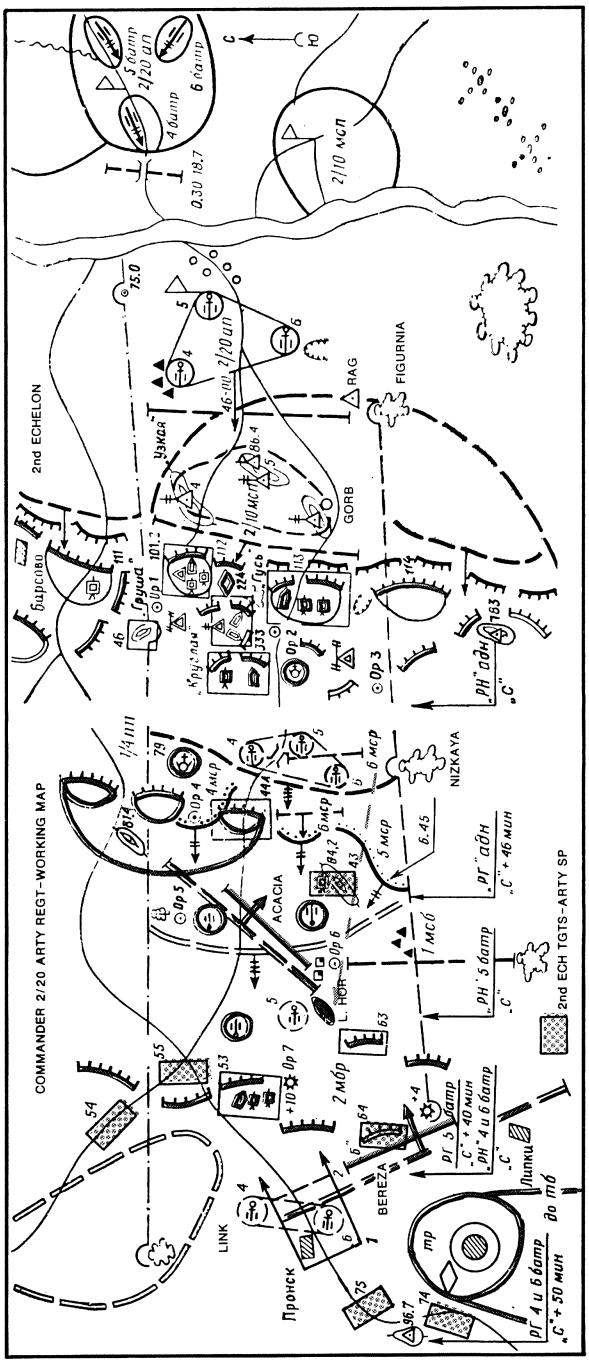


Figure 31. Working Map of Artillery Support by 2/20 Artillery Regiment.

Enclosure 8 to
Appendix 2 to Annex D

Start time of firing	Gun Position No and Co-ordinates	Fire Missions	Order of Fire	Ammo Expenditure	Remarks
052340 Sep	1. x = 19220 y = 53610	Neutralise tgt 19 inf with fire wpns	Adjustment by observation	HE: 20 Illum: 8	
050220 Sep	2. x = 19170 y = 53120	Neutralise tgt 20 Op.	Adjustment with aid SND	HE: 30	
060450 Sep	1. x = 19220 y = 53610	Neutralise tgt 20 Op.	Adjustment by observation	HE: 20 Illum: 8	
060820 Sep	3. x = 18410 y = 53530	Neutralise inf defence South GROMOVO	Adjustment with aid rangefinder	HE: 25	
061315 Sep	2. x = 19130 y = 53120	Neutralise again located tgts	Adjustment with aid rangefinder	HE: 25	

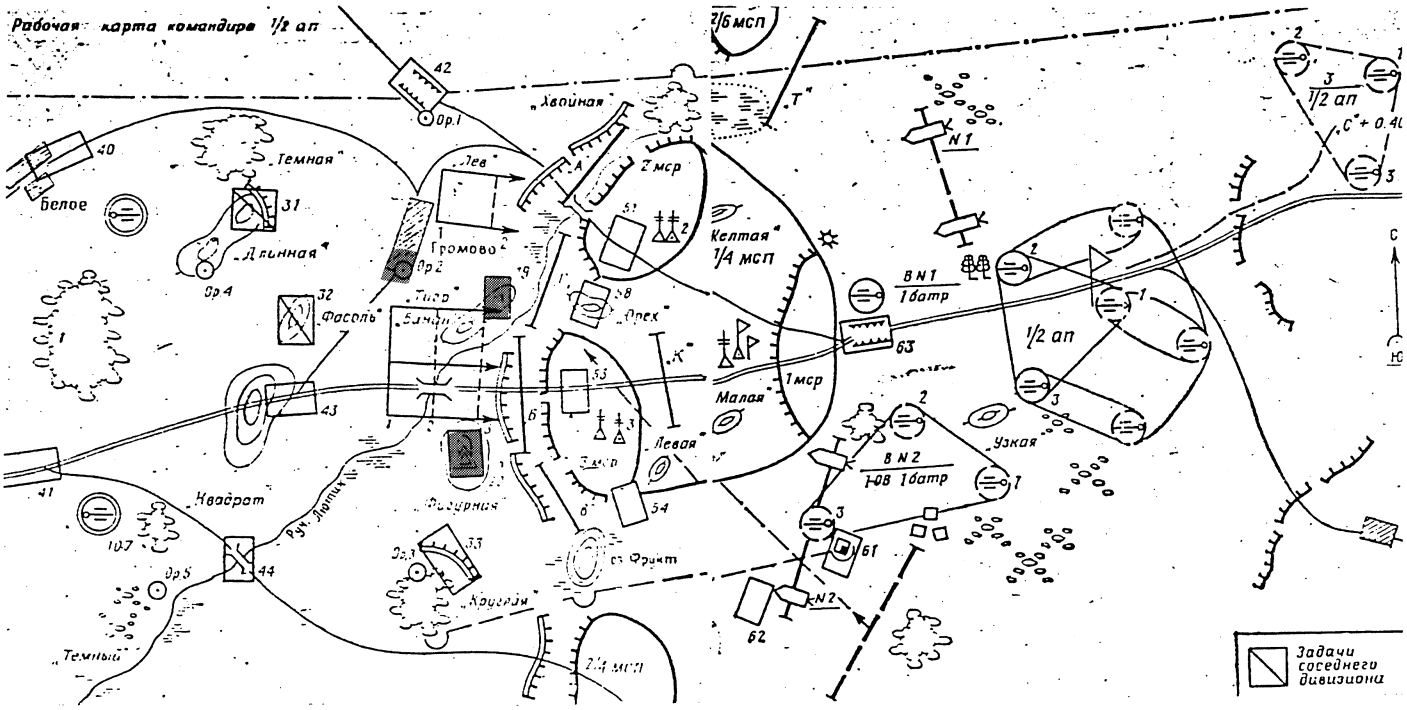


Figure 32. Plan of Operation - Roving Troop 1/2 Arty Battalion in Defence.*

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* Artilleriyskiy Divizion v Boyu, G. E. Peredelskiy, p.186.

Appendix 3 to Annex D

COUNTER-BOMBARDMENT AMMUNITION EXPENDITURE NORMS.

Table 86. Counter-Bombardment - Average Ammunition Norms for Neutralisation of Artillery and Mortar Batteries and for Destruction of Nuclear Delivery Means - by Predicted Fire at Ranges up to 10km.

Designated Targets	Rifled Artillery							Mortars			Rocket Arty	
	Guns				How		Gun/How					
	Calibre (mm)				Calibre (mm)			Calibre (mm)				
	85	100	122	130	122	152	152	120	160	240	Med	Hvy
Arty Bty - towed	280	240	220	200	220	180	180	200	120	100	400	170
Mor Tp - Towed	210	180	165	150	165	135	135	150	90	70	300	130
SP Bty - Armoured	330	300	270	260	380	300	285	300	290	175	440	210
SP Bty - Unarmoured	310	265	240	230	310	260	240	250	240	130	380	170
SP Tp - Unarmoured	270	230	200	200	270	220	205	210	200	115	350	150
Tp/Pln - SP Mortars	400	360	320	310	430	330	310	320	300	170	540	230
Destruction - Nuc Del Means - Launcher	350	320	260	240	260	200	200	-	140	110	270	200
Neutralisation - Nuc Del means - Gun rds per min.	12	10	8	7	8	6	6	-	6	5	7	6

Table 87. Ammunition Norm for Neutralisation of Self-Propelled Armoured Battery by Three Batteries.

Detail	Norms in FMs* at Ranges in Kms						
	4	6	8	10	12	14	16
Norms - 152mm How	196	241	334	438	645	-	-
Norms - 152mm Gun How	156	245	312	407	457	698	902
Norms - 130mm Gun	109	187	294	458	655	808	962

Table 88. Norm for Neutralisation of Self-Propelled Unarmoured Battery by Three Batteries.

Detail	Norms in FMs* at Ranges in Kms						
	4	6	8	10	12	14	16
Norms - 152mm How	168	204	279	634	528	-	-
Norms - 152mm Gun How	136	215	260	336	458	585	752
Norms - 130mm Gun	100	101	256	386	538	664	790

---

* FM - Fire Mission.

Table 89. Ammunition Norms for Neutralisation of a Troop/Battery Self-Propelled Unarmoured Guns in Engagements by Three Batteries.

Target details	Soviet Weapon System	Ammo Norms in FMs at Ranges in Kms						
		4	6	8	10	12	14	16
Norm - Neutralisation troop of SP unarmoured guns	152mm How	136	169	237	317	480	-	-
	152mm Gun How	112	178	226	278	410	532	702
	130mm Gun	82	143	218	328	412	610	740
Norm - Neutralisation two troops/battery of SP unarmoured guns	152mm How	272	338	474	634	960	-	-
	152mm Gun How	224	356	452	556	820	1064	1404
	130mm Gun	164	286	436	656	984	1220	1480
Norm - Neutralisation Battery SP unarmoured guns - troop centres 300m apart (two troops)	152mm How	350	426	555	680	895	-	-
	152mm Gun How	289	446	532	645	810	976	1116
	130mm Gun	212	346	512	724	960	1130	1330
Norm - Neutralisation of battery when all guns are positioned as a battery (i.e. not split into two troops)	152mm How	168	209	273	364	528	-	-
	152mm Gun How	136	215	260	336	458	582	752
	130mm Gun	100	161	256	386	538	664	790

Table 90. Minimum Number of 152mm Gun/How Required for Neutralisation of Enemy Artillery Battery.

Duration of Engagement	Minimum Number of Guns at Ranges of				
	8km	10km	12km	14km	16km
15mins	5* / 7**	5 / 7	7 / 13	8 / 19	10 / 25
20mins	4 / 6	4 / 6	5 / 11	7 / 15	8 / 20
25mins	3 / 5	3 / 5	5 / 10	6 / 14	8 / 19

---

* Figures above the line in the distance boxes show the number of gun/hows required for neutralisation of towed battery.

** Figures below the line in the distance boxes show the number of gun/hows required for neutralisation of SP armed battery.

Table 91. Minimum Amount of Artillery Sub-Units Required for Neutralisation of One Artillery Battery/One Mortar Troop (Platoon).

Type of Enemy Battery	Quantity of Batteries needed for Neutralisation of Arty Bty/Mor Tp		
	Range - less than 10km	Range - from 10-15km	Range - above 15km
Arty Bty or Mor Tp Towed	1 bty*	1/2 btys	2/3 btys
SP Bty SP Mor Tp Armd/ Unarmd	1/2 btys	2/3 btys	Not less than division (3 x bty)

Table 92. Required Number of Guns for the Destruction of Missile Launcher.

Calibre Gun System	Range Km	'Norm' Ammo	Max Permissable Rates of Fire - one Gun			Required Number of Guns for FMs in course of		
			5 min	10 min	15 min	5 min	10 min	15 min
130mm Gun	10	240	20	35	45	12	7	6
	15	480	20	35	45	24	14	11
	20	720	20	35	45	36	21	16
152mm Gun How	10	300	20	30	40	10	7	5
	15	400	20	30	40	20	14	10

* In the destruction (i.e. 60% kill and above) of an enemy battery it is necessary to obtain three times as much artillery as shown in Table 91 of Appendix 3 to Annex D, i.e. (destruction of one towed battery at range of less than 10km will require one artillery battalion (3 batteries).

From Table 92 it follows, that for the destruction of a missile launcher in a period of 10 to 15 minutes:

in ranges up to 10km - one battery

in ranges from 10-15km - two/three batteries

in ranges from 15-20km - note less than division (3 x bty)

For the destruction of guns, which are able to fire nuclear ammunition, it follows that at least one battalion is required, perhaps more, in view of the fact that the norm of ammunition for its destruction is two times greater than for a missile launcher.

Appendix 4 to Annex D

Table 93. Ammunition Norm for Stationary Unobserved Targets.

	Type of Target and Fire Mission	Rifle Artillery							Mortars				Rocket Artillery		
		Calibre mm													
		76	85	100	122	130	152	203	82	120	160	240	Med	Med Long	Hvy
1	Bty - SAM (neutralisation)	250	240	200	150	150	100	60	-	-	-	-	-	200	100
2	Unprotected Vehs/ Radars (neutralisation)	420	360	280	180	180	120	60	350	180	80	40	300	240	120
3	Well protected pers/wpns in well prepared def posn (neutralisation - on 1 hectare of tgt (100 x 100m)	480	450	320	200	200	150	60	-	200		50	320	240	100
4	Protected pers/ wpns, tanks and APCs in hastily occupied strong-points conc areas FUPs and SLs (neutralisation - on 1 hectare)	400	350	250	150	150	110	45	300	140	85	45	240	180	80
5	Unprotected pers/ wpns in conc area FUPs, strongpoint (neutralisation - on 1 hectare)	50	45	30	20	20	15	5	35	10	8	4	10	8	5
6	CP - dug in (neutralisation - on 1 hectare)	480	450	320	200	200	150	60	-	200	100	50	320	240	100

	Type of Target and Fire Mission	Rifle Artillery							Mortars			Rocket Artillery		
		Calibre mm												
		76	85	100	122	130	152	203	82	120	160	240	Med	Med Long	Hvy
7	CP - Veh borne	120	100	80	50	50	40	25	-	25	20	10	30	20	15
8	Unprotected a/tk msl launchers (neutralisation)	250	80	180	140	140	100	50	240	140	80	35	-	-	-

Table 94. Ammunition Norm on 1 Hectare (100m^2) of Strongpoint of Well Prepared Defence in Engagement by Battalion - 152mm Gun How.

Strongpoint Dimensions F x D	Ammunition Norm in FMs at Ranges in KM				
	6	8	10	12	14
200 x 200	165	188	208	230	288
200 x 300	132	146	159	173	212
300 x 200	143	164	166	197	236
400 x 200	135	152	165	183	214
200 x 400	168	129	138	147	175
300 x 300	115	126	136	148	174
Average Effective Value	131	151	162	180	215
'Norm'	150	150	150	180	210

Table 95. Probability/hastily Occupied Enemy Strongpoint which is Engaged by Battalion 122mm How in up to 10km Range.

Duration of Engagement Min	Effective Fire Probability shown in hectares in Density of Suppression		
	50%	75%	100%
5	6.0/2.0*	4.0/-	3.0/-
10	9.6/3.2	6.4/2.1	4.8/-
15	13.2/4.4	8.8/2.9	6.6/2.2
20	16.2/5.4	10.8/3.6	8.1/2.7

* Figures for division are first/figures for battery are second.

Table 96. Probability/Hastily Occupied Enemy Strongpoint Engaged by 122mm How Battalion at 15km Range.

Duration of Engagement Min	Effective Fire Probability shown in hectares in Density of Suppression		
	50%	75%	100%
5	4.0/-*	-/-	-/-
10	6.4/-	4.3/-	3.2/-
15	8.8/2.9	5.9/-	4.4/-
20		7.3	5.4/-
		2.4	

---

* Figures for artillery battalion are first/figures for battery are second.

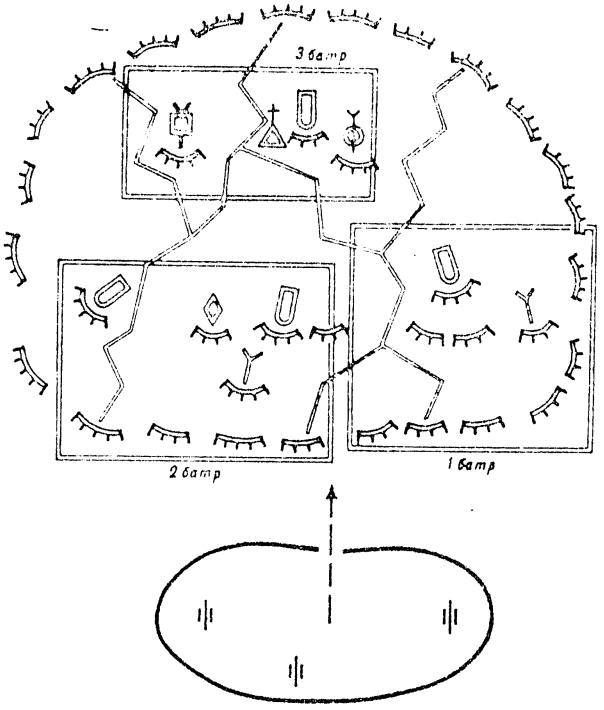
1. Predicted bombardment using 3 sightsettings for range and one for direction.

2. Tgt dimensions 300 x 200m.

3. Carried out by 152mm Gun How artillery battalion at a range of 6000m.

	1 Bty per gun	2 Bty per gun	3 Bty per gun
First firing	4rds Rapid 6rds FFE	4rds Rapid 6rds FFE	4rds Rapid 6rds FFE
Second firing	6rds FFE	6rds FFE	6rds FFE
Third firing	6rds FFE	6rds FFE	6rds FFE
Possible Ammo Expenditure (min) Totals	24} 36} x 3 = 132 x 3 = 396 at 6km 36} 36}		

Figure 33. Predicted Bombardment of Unobserved Strongpoint.



Each battery has its own designated area of bombardment.

Figure 34. Observed Bombardment of Group Target by Artillery Battalion - Three Batteries.

Table 97. Expenditure of Shells to Neutralise (30% kill) a Battery of SP Unarmoured Guns Engaged by Three Batteries.

Task	Means	Expenditure of Shells for Distances in km						
		4	6	8	10	12	14	16
To engage platoon	152mm How	136	169	237	317	480	-	-
	152mm Gun How	112	178	226	278	410	532	702
	130mm Gun	82	143	218	328	412	610	740
To engage battery (2 platoons)	152mm How	272	338	474	634	960	-	-
	152mm Gun How	224	356	452	556	820	1064	1404
	130mm Gun	164	286	436	656	984	1220	1480
To engage battery of 2 platoons 300m apart simulataneously	152mm How	350	426	555	680	895	-	-
	152mm Gun How	289	446	532	645	810	976	1116
	130mm Gun	212	346	512	724	960	1130	1330
To engage battery where all guns are dispersed	152mm How	168	204	273	364	528	-	-
	152mm Gun How	136	215	260	336	458	585	752
	130 Gun	100	161	256	386	538	664	790

Appendix 5 to Annex D

Table 98. Maximum Permitted Rates of Fire for Guns, Gun-Hows and Hows (a).

Duration of fire mins	76mm Gun		85mm Gun		100mm Gun		122mm Gun		130mm Gun		152mm How	
	charge		charge		charge		charge		charge		charge	
	full	red	full	red	full	red	full	red	full	red	full	red
1	15	15	10	10	7	7	6	6	5	5	4	4
3	35	35	25	25	18	18	16	16	12	12	12	12
5	50	50	40	40	30	30	25	25	20	20	20	20
10	70	70	50	60	50	50	40	40	35	35	30	30
15	85	85	60	75	60	65	55	55	45	45	40	40
20	100	100	70	90	65	75	65	70	55	55	50	50
25	110	115	80	100	70	90	70	80	65	65	60	60
30	115	130	90	110	75	100	75	90	70	75	65	70
40	125	160	110	130	85	120	85	110	80	90	75	90
50	140	180	125	150	90	140	90	130	90	105	80	105
60	150	200	140	170	95	100	100	150	100	120	90	120
120	220	320	230	290	135	250	150	260	100	210	135	210
For Each Successive Hour												
	70	100	80	100	40	80	50	80	35	70	45	70

Table 99. Maximum Permitted Rates of Fire for Guns, Gun-Hows and Hows (b).

Duration of fire mins	152mm Gun/How charge		152mm Gun/How charge		76mm Mtn Gun	System T12	203mm How
	full	red	full	red	one charge	one charge	one charge
1	4	4	4	4	20	7	1
3	12	12	12	12	40	20	2
5	20	20	20	20	60	35	3
10	30	30	30	30	65	45	6
15	40	40	40	40	80	55	9
20	50	50	50	50	90	60	12
25	55	60	60	60	100	65	15
30	65	70	65	70	110	70	18
40	70	80	75	80	130	75	22
50	85	95	80	95	145	90	26
60	80	110	90	110	160	100	30
120	120	200	135	200	260	-	60
For Each Successive Hour							
	35	60	45	60	90	-	25

Appendix 6 to Annex D

Table 100. Maximum Permitted Rates of Fire-Mortars.

Duration of Fire mins	82mm Mortar		120mm Mortar		160mm Mortar	240mm Mortar	
	10 Vane Mortar Bomb	6 Vane Mortar Bomb	Largest bomb	Smallest bomb	All Charges	All Charges Less Special	Special
1	10	20	9	9	3	1	1
3	45	45	25	25	9	3	3
5	75	60	30	30	12	5	5
10	110	75	35	35	18	10	10
15	125	85	40	40	21	15	13
30	150	100	50	75	30	30	20
60	210	140	70	105	48	38	25
120	-	-	110	165	88	51	35
180	-	-	150	225	128	64	45

Table 101. Maximum Permitted Rates of Fire - Rocket Artillery - Salvos.

Duration of Fire mins	Rocket Artillery					
	Medium		Medium Long Range		Heavy	
	Bty	Division	Bty	Division	Bty	Division
3*	1	1	1	1	1	1
10	2	2	2	2	-	-
15	3	-	-	2	2	2
20	-	3	3	-	-	-
25	4	-	-	-	3	-
30	5	4	4	3	-	3
40	6	-	-	-	4	-
45	-	5	5	4	-	4
50	7	-	-	-	5	-
60	8	6	6	5	6	5
For Each Successive Hour	6	4	4	3	4	3

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* Launchers are already loaded for first salvo.

ANNEX E

EXAMPLES OF NORMS IN MATHEMATICAL MODELLING.

			Page
Calculating the march, movement and deployment	Appendix 1	(Nomograms 1-8) (Figures 35-43) (Tables 102-103)	520
Calculating engagement and battle with and pursuit of the enemy. Requirement for weapons densities and ammunition replenishment	Appendix 2	(Nomograms 9-14) (Figures 44-48) (Tables 104-106)	546
Calculations for river crossing, minefields and engineering fortifications	Appendix 3	(Nomograms 15-18) (Figures 49-52) (Tables 107-108)	574
Calculating artillery engagements	Appendix 4	(Nomograms 19-21) (Figures 53-55) (Table 109)	591
Calculating transport requirements by road, rail and air	Appendix 5	(Nomograms 22) (Figure 56) (Tables 110-113)	604

EXTENSION OF NORMS IN TO MATHEMATICAL MODELLING, NOMOGRAMS AND CALCULATION FORMULAE.

Nomograms and calculation proformae are designed to assist in achieving a clear cut appreciation of a particular situation based on a common approach to a problem, and to produce a solution in the shortest possible time.

Group 1. In Group 1 there are two examples of particular interest:

(a) Nomogram No 2, Appendix 1. This could be used in the commitment to battle of a second echelon sub-unit, unit or formation. The timing for the committal of a second echelon to battle is critical if the advance is to be developed without a halt. The committal to battle of the second echelon must be before the advance shows signs of slowing up or the impetus will be lost. On the other hand, if the committal of the second echelon is premature, unnecessary casualties will ensue and the shock of the attack will be lessened. The accurate plotting and reconnaissance of the second echelon startline (SL) is vital.

(b) Nomogram No 8, Appendix 1. In the calculation, 'n' denotes the norm of fuel consumption for 100km in litres and 'k' denotes the additional factor for movement conditions. In the example, K = 1.2 (i.e. depicts a worse movement condition than a movement coefficient of K = 1.0, perhaps due to hilly ground or swamps, etc.), this represents the additional supplement of 20% to the fuel norm.

Group 2. In this category the "meeting engagement" is of particular interest. (Nomogram No 9 and Proformae Nos 3 and 4, and Nomogram No 13 - the required number of anti-tank weapons to destroy tanks). This calculation can be reversed to work out the number of tanks required to affect a breakthrough. See also Nomogram No 14 (the determination of the number of weapons to carry out a task and their effectiveness). In Proforma No 5 for the determination of the necessary manpower and weapons to restore sub-units and, units to battle worthiness, note that the restoration need not necessarily be up to the original establishment but merely sufficient to obtain the required degree of superiority.

Group 3. Includes crossing water obstacles, mining, engineer fortifications and improvements.

Group 4. This category covers artillery in "engagement of personnel and

weapons" - Nomogram No 18 enables a quick appreciation of the engagement to be made, Nomogram Nos 19 and 20 "duration of fire in a gun position" and "time spent in changing gun positions", tells us how long the battery or artillery battalion will be non-effective in terms of bringing fire to bear on targets. See also Proforma No 7 "calculation of fire capabilities".

Group 5. Covers logistics:- the transportation of loads by road, rail and by air.

Appendix 1 to Annex E

NOMOGRAM 1. Duration of a March.

The method of calculating the time necessary for the transfer of sub-units from one area to another is dependent on the following data: the length of march (from the startline (SL) to the nearest point of the new concentration area), the average speed of the column, the duration of halts in the course of movement and the time taken to pull off the ground into the new concentration area (which is only considered in the case when the depth of the concentration area is less than the length of the moving formation).

Formula of calculation:

$$t = \frac{D}{V} + t_n + t_{Bt}$$

where:

t = Duration of march - hours.

D = Length of route.

V = Average speed of moving column - kph.

t_n = Overall time of halts in the course of the move.

t_{Bt} = Time taken to pull off road into new concentration area.

Example of calculation by nomogram.

"Calculate the duration of a move along a 80km route with an average speed of movement is 35kph, duration of halts 1hr 30mins; time taken to pull off road into new area - 30mins.

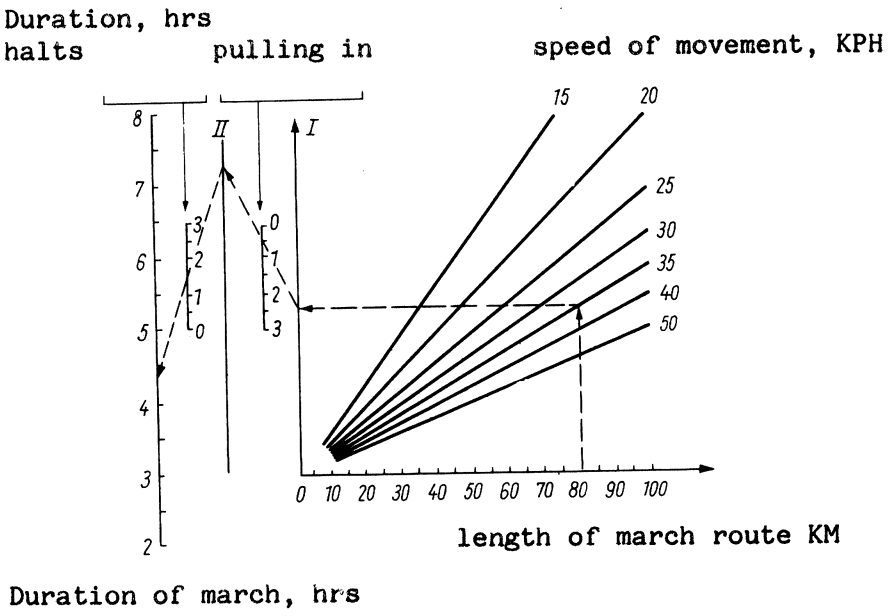


Figure 35. Nomogram for the Calculation of the Duration of a March.

Answer from the nomogram scale = 4.3hrs, i.e. 4hrs and 20 min.

NOMOGRAM 2. Duration of Column Moving Out to Startline.

The basic data for calculating when a mobile column should start moving in order to arrive at the startline in good time is the distance between the startline and the area where troops are concentrated taken together with speed of movement.

Formula of calculation:

$$t_H = T - \frac{D_u \times 60}{V_B}$$

where:

t_H = Time of column starts to move in hrs and min.

T = Time head of column passes nominated line in hrs and min

D_u = Distance of startline (or point) from concentration area of troops in km.

60 = Length of time in minutes.

V_B = Speed of movement of mobile column in pulling out in kph.

Example of calculation.

Determine the start time of a mobile column, if the time of passing the startline by the head of the column is to be 2100hrs. The distance from the startline is 9km, speed of movement of the column on moving out is 15kph.

$$t_N = 2100 - \frac{9 \times 60}{15} = 2100 - 0.36 = 20.24\text{hrs}$$

Answer: The column must commence moving out of its deployment area at 2024hrs 6 Aug to make the startline at 2100hrs.

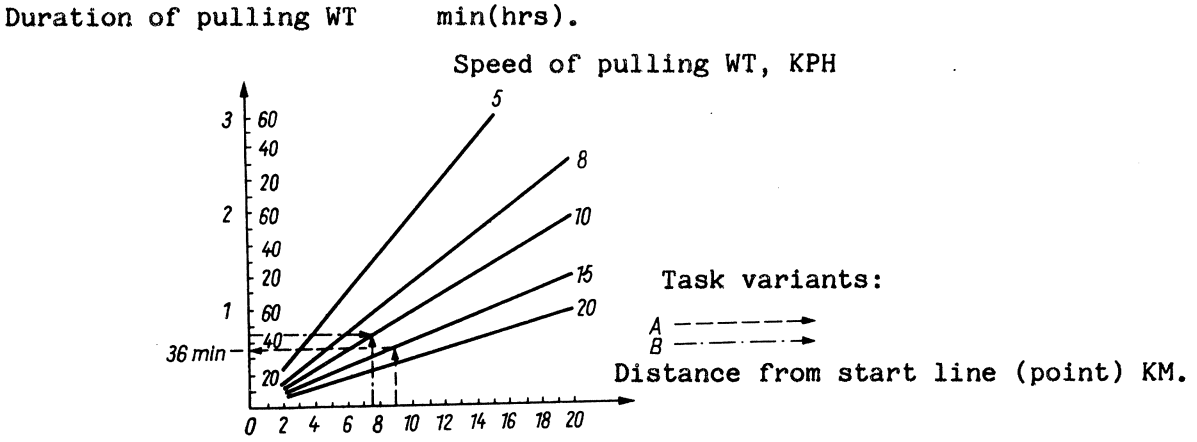


Figure 36. Nomogram for the Calculation of the Duration of Movement of Marching Columns to the Startline (Point).

Example of calculation using the Nomogram.

1. Using the same conditions as in the example above, the same answer is achieved, i.e. the time is 36min for moving from the deployment area, to the startline - the column must start to move at 2024hrs.

2. With the assistance of the nomogram it is also possible to calculate the necessary speed of movement of the column to the start line (point).

Following example b, with a distance from the deployment area of 7.5km the mobile column needs to move at a speed of not less than 10kph.

NOMOGRAM 3. Time Taken to Occupy New Concentration Area by a Mobile Column.

The time taken to occupy a new concentration area by a mobile column needs to be calculated only when the depth of the area is less than the length of the mobile column.

The depth of the concentration area, the length of the column, and the speed of movement in pulling in to the new area are the basic data for this calculation.

Formula of calculation:

$$t_{Bt} = \frac{(G_K = G_R) \times 60}{V_{Bt}}$$

where:

t_{Bt} = Time taken for mobile column to pull into new concentration area in mins.

G_K = Length of column - km.

G_R = Depth of concentration area - km.

V_{Bt} = Speed of movement of column in pulling into new area - kph.

60 = Length of time in mins.

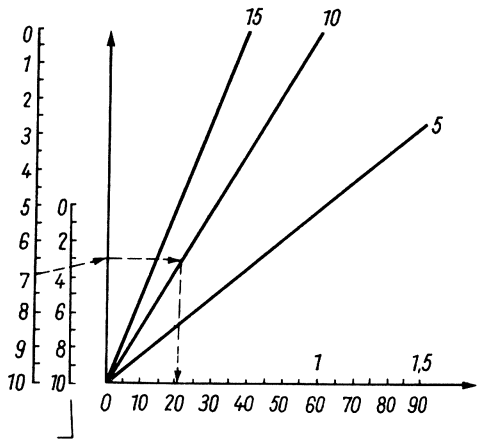
Example of calculation.

Determine the time taken by a column to occupy a new concentration area if the length of the column is 7km, depth of the concentration area is 3.5km, speed of movement of column in pulling into new area is 10kph.

Solution.

$$t_{Bt} = \left(\frac{7 - 3.5}{10}\right) \times 60 = 0.35 \times 60 = 21\text{mins.}$$

Length of marching column



Depth of concentration area, KM

Figure 37. Nomogram for the Calculation of the Length of Time Taken for a Mobile Column to Pull into new Concentration Area.

The nomogram in the example above provides the same time - 21mins.

NOMOGRAM 4. Length of Mobile Formation Consisting of Several Mobile Columns.

This method is for determining the overall length of a moving formation on a route, provided the number of vehicles in the moving columns and distances between them is known. It is also used to determine the required distances between vehicles.

Formula of the calculation:

$$G_K = \frac{N_m \times d_m + (N_K - 1) \times d_K}{1000}$$

where:

G_K = Length of moving formation in km.

N_m = Overall number of vehicles in columns.

d_m = Distances between vehicles in metres.

N_K = Number of moving columns.

d_K = Distances between columns in metres.

1000 = Coefficient of converting metres into km.

Example of calculation.

Determine the length of a moving formation consisting of four columns, if the overall number of vehicles is 169, distance between columns 600m, distance between vehicles 40m.

Solution.

$$G_K = \frac{169 \times 40 + (4 - 1) \times 600}{1000} = \frac{6760 + 1800}{1000} = 8.6\text{km}$$

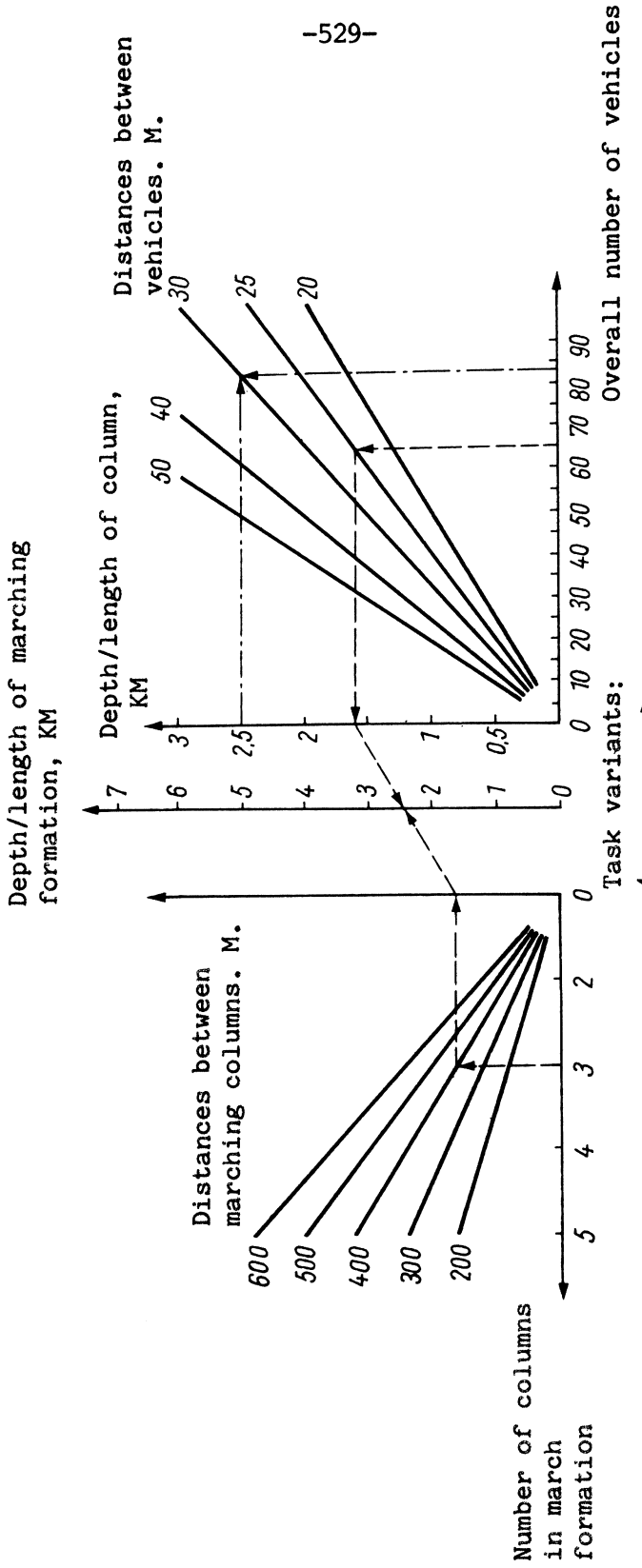


Figure 38. Nomogram for the Calculation of the Depth/Length of a Mobile Formation Consisting of Several Columns.

Example of calculation using to the nomogram.

1. Determine the length of a moving formation if there are 3 moving columns and distances between them 400m, overall number of vehicles 65, distance between vehicles 25m (variant a).

2. Determine the necessary distances in a column, consisting of 83 vehicles, given that the length of the column must not exceed 2.5km (variant b).

Solution - 30m.

NOMOGRAMS 5 and 6. Time Taken to Pass Narrow Places/Difficult Sectors of Routes.

There are two types of difficult sectors to be overcome: minor ones, of a length considerably less than the mobile columns, and larger ones, where the length is greater than the length of the mobile column. The basic data for minor sectors is the number of vehicles in the column, distances between them and speed of movement of vehicles when passing the sector. For the larger sector they are: the length of the moving column; the length of the sector to be covered, and; the speed of movement.

Formula of calculation for small obstacles:

$$t = \frac{N_m \times d_m \times 0.06}{V}$$

where:

t = Time taken to overcome obstacle in mins.

N_m = Number of vehicles in a column.

d_m = Distance between vehicles in metres.

0.06 = Coefficient of converting kph into mpm.

V = Speed of movement of vehicles in the sector to be overcome.

Example of calculation.

Determine the time taken to overcome a steep slope by a column of 54 vehicles, if the distance between vehicles is 75m, permitted speed of movement on the sector is 10kph.

Solution:

$$t = \frac{54 \times 75 \times 0.06}{10} = 24\text{mins}$$

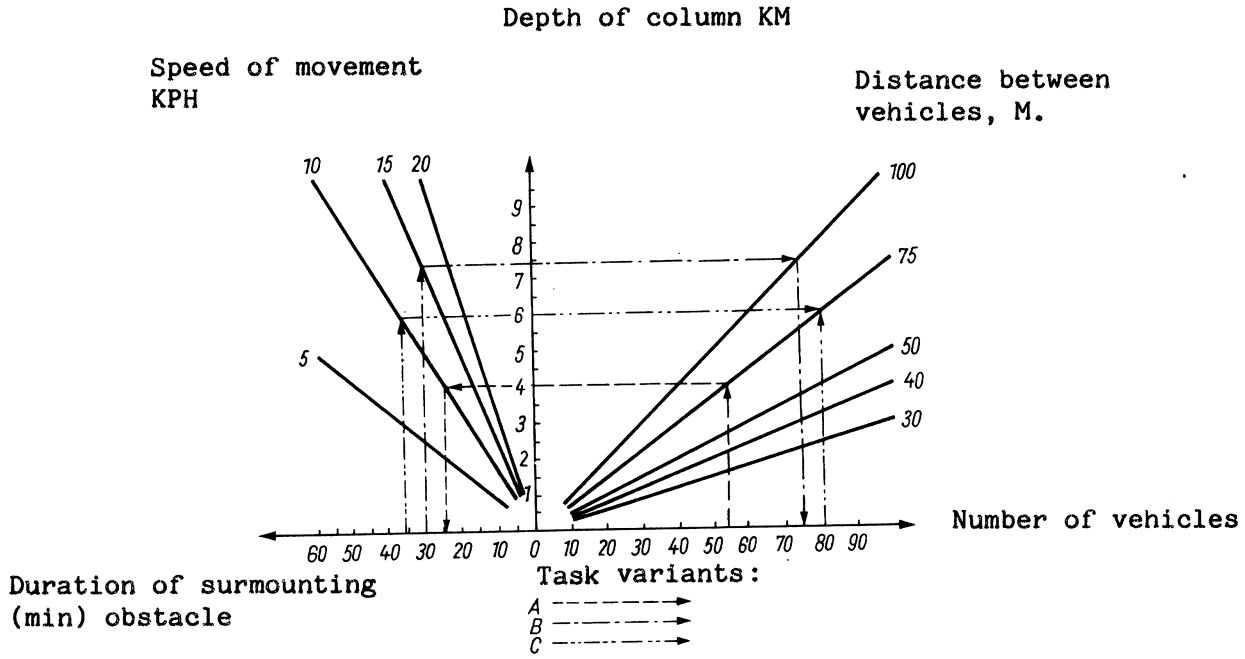


Figure 39. Nomogram for the Calculation of the Time Taken to Pass Narrow Places on Movement Routes.

Calculation using the nomogram gives - 24mins (variant a). With the assistance of the nomogram it is also possible to solve other problems. For example, (1) determine the number of vehicles able to traverse an obstacle on a route in the course of 30mins, if the required speed of movement is not more than 15kph, and the distance between vehicles 100m.

Solution: variant b on the nomograph - 75 vehicles in 30 minutes.

(2) Calculate the distance between vehicles in a column of 80 vehicles in order that the column crosses a bridge within 30 minutes at a permitted speed of not more than 10kph.

Solution: variant c.

Formula of calculation for large obstacles:

$$t = \frac{G_K + D}{V}$$

where:

t = Duration of overcoming obstacle-hours.

G_K = Length of column - km.

D = Length of sector to be overcome - km.

V = Speed of movement across the obstacle - kph.

For example of calculation using by nomograph, see Figure 40.

1. Determine the time required for overcoming a boggy strip of road, if the length of the sector is 5.5km, depth of the column 2.5km, average speed on the sector 15kmp. Solution (variant a) - 32mins.

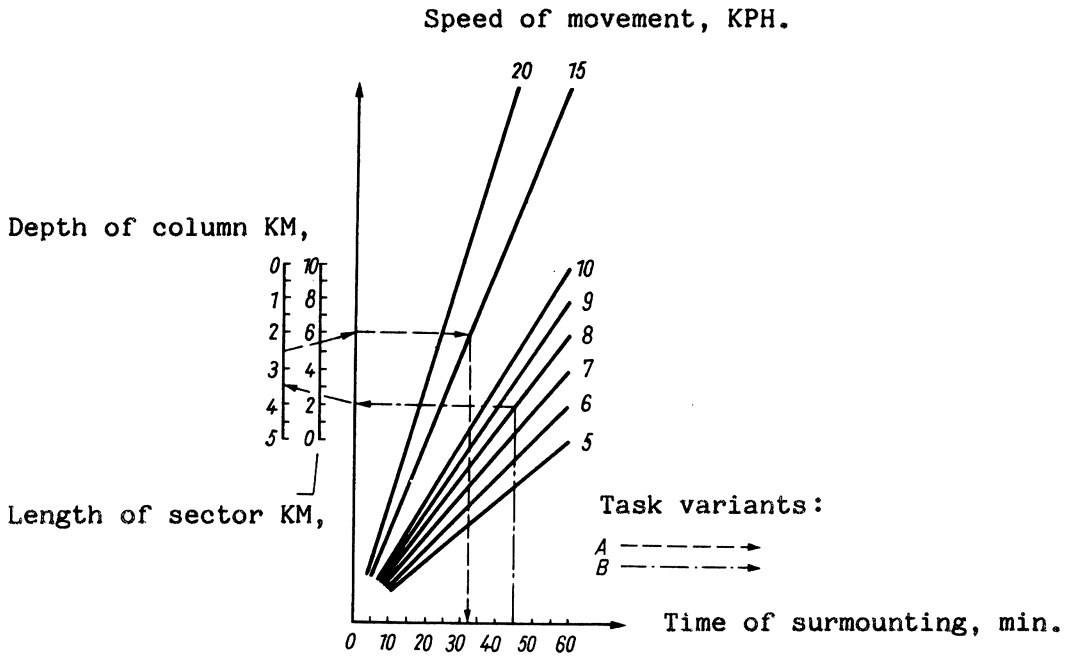


Figure 40. Nomogram for the Calculation of the Time Taken to Pass Difficult Sections on Movement Routes.

2. With the assistance of this nomogram it is possible to determine (variant b) what length of column can negotiate a pass 2.5km long at a speed of 8kph in a given time.

Solution: (variant b) - 3.5km.

NOMOGRAM 7. The Time of Passing the Startline (Point)/Report Line (Point) by the Head and Rear of a Column.

The basic data required for the calculation is: details on the makeup/construction of the moving formation, depth of moving columns and the established distances between them, speed of movement and the time of passing the other line (point) by the head of the moving formation.

Formula of the calculation:

$$t_1 = T_i - 1 + \frac{d_i}{V} \times 60; \quad t_i = t_1 + \frac{D_i}{V} \times 60$$

where:

t_i = Time of passing line (point) by head of first moving column.

t_{i-1} = Time of passing line (point) by the tail in front of the moving column in hours/mins.

d_i = The established distance between columns in km.

60 = Coefficient of converting hours to minutes.

V = Average speed of movement.

t_i = Time of passing the line by the rear of the in column.

D_i = Length in column.

Example of calculation.

Determine the time of passing control point no 1 by the head of the formation and the rear of No 3 column, if time of passing the startpoint by the rear of the column is to be 2115 hours, the distances between columns is 1.5km, the length of a column is 1.8km, speed of movement 25kph.

Solution:

$$t_3 = 2115 + \frac{1.5 \times 60}{25} = 2115 + 0.04 = 2119$$

$$t_3 = 2119 + \frac{1.8 \times 60}{25} = 2119 + 0.04 = 2123$$

i.e. the head of the third column in the movement formation passes report line No 1 at 2119hrs and the rear at 2123hrs.

Example of calculation using nomogram (Figure 41).

Determine the time to pass a startline by the head and rear of a moving column of 7km, when the distance between columns is 5.5km and the speed of movement is 25kph.

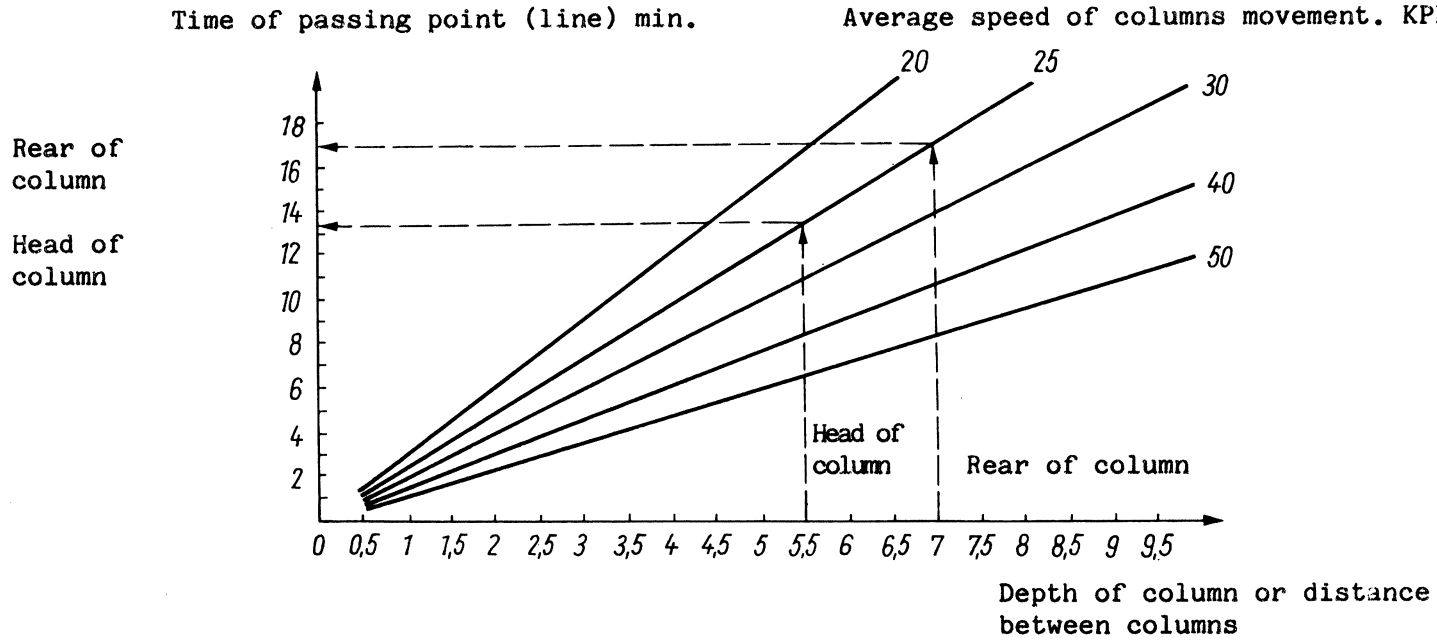


Figure 41. Nomogram for the Calculation of the Time of Passing a Line (Point) by the Head and Rear of a Column.

The nomogram gives 13.3 minutes for the front of the column. Rear of the column 17 minutes. So that the front column will be clear of the start line by 2030 (i.e. 2013 (head passing) and 0.17 (rear passing).

Proforma No 1. For the Calculation of Transit Time to a New Area.

Formula of calculation.

$$t = T + D + \frac{G_K}{V} - \frac{G_P}{0.6V} + t_R \text{ in } \sqrt{G_K \cdot G_R}$$

where:

t = Duration of regrouping to new area in hrs.

T = Time (astronomical) of passing start point (line) by front of column in hrs/mins.

D = Length of route and distance away of new concentration area in km.

V = Average speed of movement.

G_K = Length of column.

G_P = Depth of new concentration area in km (considered only when the depth is less than the length of column).

0.6 = Coefficient, which takes into account the lowering of the average march speed in drawing into the new concentration area.

t_n = Duration of halts en route in hrs.

Table 102. Proforma to Calculate Transit Time to the New Area.

Ser No.	Starting Data Determined Scales and Oprations and Operations	Degree of Accuracy Accuracy	Variant of move forward Example	1	2	3	Remarks
1	2	3	4	5	6	7	8
1	Length of march route	km (1.0)	167				
2	Average speed of movement	kph (1.0)	18				
3	Length of mobile column	km (0.1)	7.5				
4	Depth of concentration area	km (0.1)	4				
5	Duration of halts	hrs (0.1)	1.5				
6	Time of passing start point (line) (SL) (SP)	hrs mins	10.00				
7	(2):(2)	(0.1)	9.3				
8	(3)-(4)	(0.1)	3.5				
9	(2)x(0.6)	(0.1)	10.8				
10	(8):(9)	(0.1)	0.3				
11	Overall duration of march (5)+(7)+(10)	hrs (0.1)	11.1				
12	Time of concentration in new area (6)+(11)	hrs mins	21.06				

Proforma No 2. Length of Route, Average Speed and Duration of Movement of Moving Column.

Formula of calculation:

$$D = \sum_{i=1}^{n} L_i \qquad t_d = \sum_{i=1}^{i} \frac{L_i}{V_i} \qquad V = \frac{D}{t_d};$$

$$t = t_d + G_K - G_P + t_n$$

$$\frac{}{0.06V}$$

where:

D = Length of route - km.

L_i = Length of sector of different tyes of road allowing V speed of movement of columns in km.

t_d = Overall time on the route in hrs.

V_i = Speed of movement on a type of sector of the route in kph.

V = Average speed of movement in kph.

G_K = Length of column in km.

G_P = Depth of concentration area in km.

0.6 = Coefficient of reduction in speed in the drawing in of the column, depending on local conditions.

t_n = Overall time of halt.

Table 103. Proforma for the Calculation of the Length of March Routes, of Average Speed, of the Duration of Movement of Marching Columns.

Ser No.	Starting Data Determined Scales and Operations	Degree of Accuracy	No. of Routes			Remarks
			Example	1	2	
1	2	3	4	5	6	7
1	Length of metalled roads	km (1.0)				
2	Speed of movement (metalled)	35				
3	Length of improved dirt roads	18				
4	Speed of movement (improved dirt roads)	25				
5	Length of dirt roads	21				
6	Speed of movement on dirt roads	15				
7	Length of field tracks	8				
8	Speed of movement (field tracks)	10				
9	Length of moving column	6.8				
10	Depth of concentration area	3				
11	Overall time for halts	1.5				
12	Length of march route (1)+(3)+(5)+(7)	89				
13	(1):(2)	1.2				
14	(3):(4)	0.7				
15	(5):(6)	1.4				
16	(7):(8)	0.8				
17	Time of movt. (13)+(14)+15)+(16)	4.1				
18	Average speed. (12)+(17)	22				
19	(9)-(10):0.6:(18)	3.8				
20	Time of movement to new area: (19):0.6):(18)	0.3				
21	Duration of transit:(11)+(17)+(20)	5.9				

NOMOGRAM 8. Amount of Fuel for Vehicles on the March.

The basic data for the calculation is: (1) the length of the march route; (2) fuel consumption for the type and mark of vehicle. The fuel consumption is calculated with a coefficient which takes into account conditions affecting movement (state of the road, weather, time of year, time of day, etc.).

Formula of calculation:

$$Q = \frac{D \times n \times K \times N}{100}$$

where:

Q = Required amount of fuel in litres.

D = Length of march route in km.

n = Norm of fuel consumption in litres/100km.

K = Coefficient introduced for the march conditions.

N = Number of vehicles of a given type.

Example of calculation.

Determine the required quantity of fuel for 75 vehicles to complete a march of 150km, if the norm of fuel consumption is 35 litres (per 100km) and the coefficient of the conditions of movement is 1.2.

Solution:

$$Q = \frac{150 \times 35 \times 1.2 \times 75}{100} = 4725 \text{ litres}$$

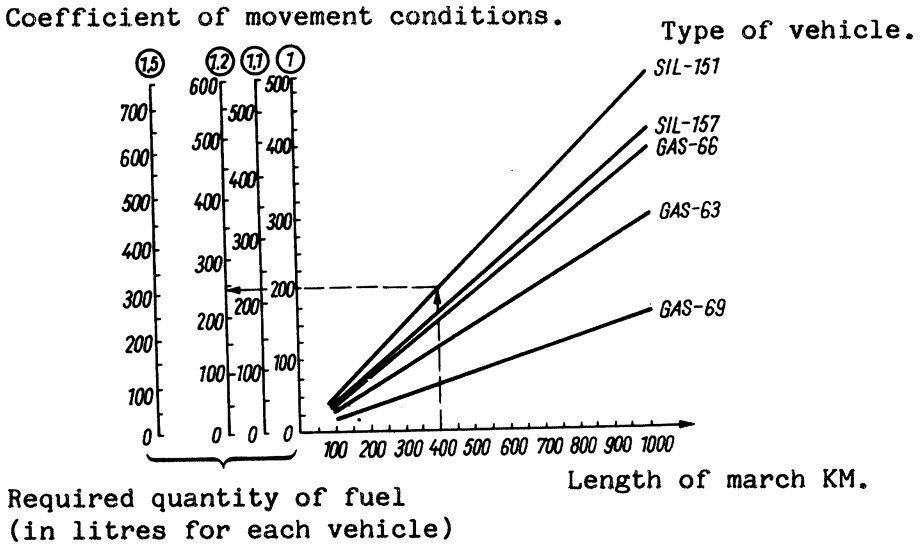


Figure 42. Nomogram for the Calculation of the Required Quantity of Fuel on the March.

Example of calculation using the nomogram.

To determine the fuel consumption for 35 ZIL 157 on a route of 400km, if the coefficient of movement conditions is 1.2.

The nomogram gives 240 litres - for each vehicle for 400km. Therefore for 35 vehicles 240 x 35 - 8400 litres.

Appendix 2 to Annex E

NOMOGRAM 9. Expected Time of Meeting and the Distance of the Probable Line of Meeting with the Enemy (encounter battle).

The expected time of meeting and the probable line of meeting with the enemy is determined taking by into account the reciprocal distances of the troops of both sides and the average speed of their movement.

Formula of the calculation:

$$t_3 = \frac{D}{V_H + V_n} \; ; \; L_P = t_B \times V_H$$

where:

t_B = Expected time of meeting with the enemy in km.

D = Distance between the troop groupings of both sides in km.

V_H = Speed of movement - own troops in kph.

V_n = Speed of movement - enemy troops in kph.

L_P = Distance of probable line of meeting with the enemy from the starting point (FUP) of own troops.

Example of calculation.

Determine the expected time of meeting and distance of the possible line of meeting with the enemy, if the enemy is situated at a distance of 63km, his average speed of movement 25kph, average speed own troops 20kph.

Solution.

$$t_B = \frac{63}{20 + 25} = \frac{63}{45} = 1.4\text{hrs} = 1\text{hr } 24\text{mins}$$

L_P = 1.4 x 20 = 28km.

Solution: the meeting with the enemy is likely in 28km and 1hr 24mins.

Example of calculation using nomogram.

Determine the expected time of meeting and the distance of the probable line of meeting with the enemy if at 1800hrs 5 June the advancing enemy is 64km away, average speed of his movement is 15kph, speed of movement of own troops is 20kph.

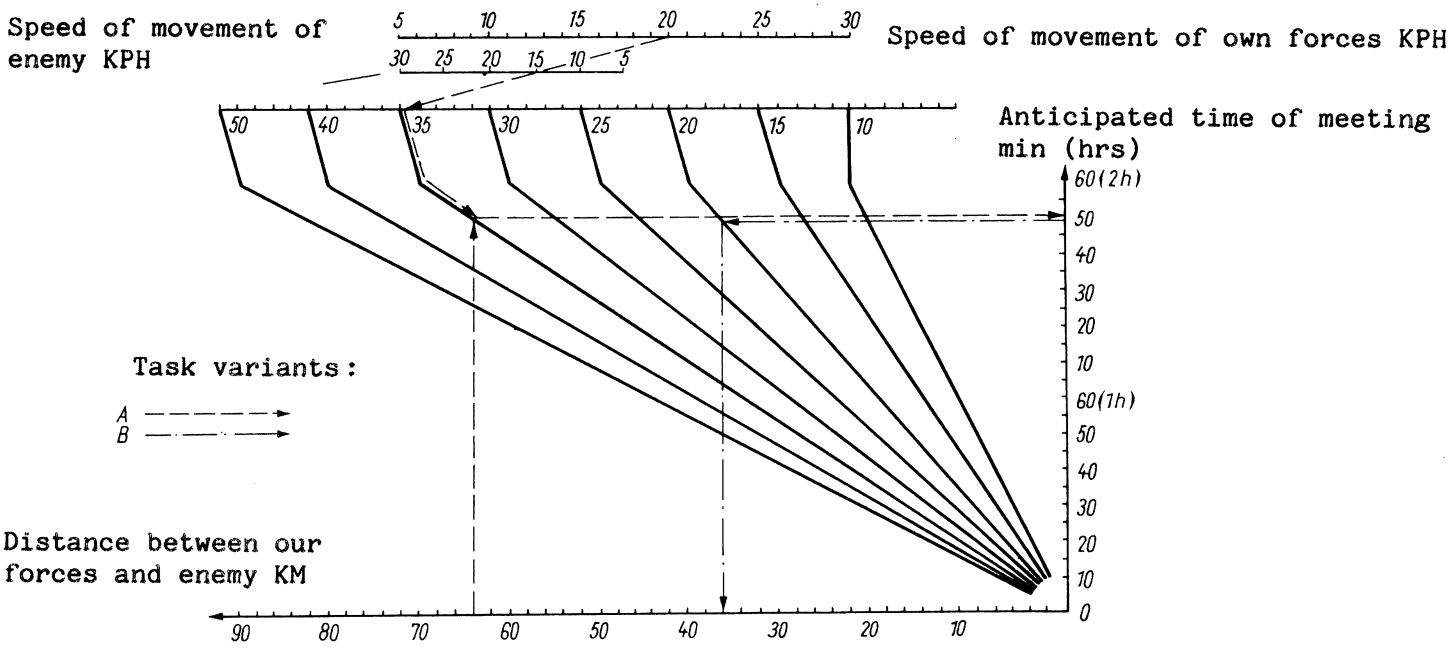

Speed of movement of enemy KPH
5 10 15 20 25 30
30 25 20 15 10 5
Speed of movement of own forces KPH
50 40 35 30 25 20 15 10
Anticipated time of meeting min (hrs)
60(2h) 50 40 30 20 10 60(1h) 50 40 30 20 10 0
Task variants:
A
B
Distance between our forces and enemy KM
90 80 70 60 50 40 30 20 10

Figure 43. Nomogram for the Calculation of the Likely Time and the Distance of the Probable Line of Meeting with the Enemy.

The nomogram gives (variant a) - 1hr and 50min - i.e. 1950hrs.

Calculating the distance of the probable line of meeting with the enemy (variant b), from the point of time 1hr 50min horizontally to line-speed 20kph, (variant b) gives 36km.

Table 104. Proforma for Calculation of time of Advance and Deployment of Sub-Units in Switching to the Attack from the March.

Ser No.	Starting Data Determined Scales and Operations	Degree of Accuracy	Variant of Move Forward		
			1	2	3
1	Distance of bound (switching to the attack) from enemy front line	km (0.1)			
2	Distance of bound (deployment into company columns) from bound (switching to the attack)	km (0.1)			
3	Distance of bound (deployment into battalion columns) from the bound (into company columns)	km (0.1)			
4	Distance of bound (regulatory) from bound (deployment into battalion columns)	km (0.1)			
5	Distance of bound (point) regulatory from the start line (point) (SL) (SP)	km (1.0)			
6	Distance of SL(SP) from sub-units location	km (0.1)			
7	Speed of movement into the attack	km (1.0)			
8	Average speed of sub-units	km (1.0)			
9	Length/depth of moving column - 1st echelon	km (0.1)			
10	Distance between columns of 1st and 2nd echelon	km (0.1)			
11	(1) x (60)	(1.0)			
12	Time of move forward to bound of switching to the attack (H-)	min (1.0)			
13	(2) x (90)	(1.0)			

Ser No.	Starting Data Determined Scales and Operations	Degree of Accuracy	Variant of Move Forward		
			1	2	3
14	(13):(8)	(1.0)			
15	Time of move forward to bound (deployment into company columns)	min (1.0)			
16	(3) x (60)	(1.0)			
17	(16):(18)	(1.0)			
18	Time of move forward to broad (deployment into battalion columns) (H-):(15) + (17)	min (1.0)			
19	(4) x (60)				
20	(19):(18)	(1.0)			
21	Time of passing bound (regulatory) (H-):(18) + (20)				
22	(5) x (60)	(1.0)			
23	(22):(8)	(1.0)			
24	Time of passing SL(SP) (H-)	min (1.0)			
25	(6) x (90)	(1.0)			
26	(25):(8)	(1.0)			
27	Time of beginning of pulling out of 1st echelon (H-)	min (1.0)			
28	(9) + (10)	(0.1)			
29	(28) x (90)	(1.0)			
30	(29):(8)	(1.0)			
31	Time of passing SL(SP) of 2nd echelon (H-):(24) - (30)	min (1.0)			

Table 105. Proforma for the Calculation of the Time and Distance of the Probable Line of Contact/Meeting with the Enemy.

Ser No.	Starting Initial Determined Scales and Operations	Degree of Accuracy	Variant of Move Forward		
			Example	1	2
1	Start of move forward of own troops	hrs mins	20.00 4/6		
2	Start of move forward of enemy tps	hrs mins	21.00 4/6		
3	Distance between groups	km (1.0)	105		
4	Delay of move forward of own troops (relative to enemy troops):(1) - (2)	hrs (0.1) in(1)>(2)	-		
5	Overall duration of halts of own forces 'en route'	hrs (0.1)	0.3		
6	Overall duration of delay of own troops by the enemy	hrs (0.1)	-		
7	Speed of movement of own troops	kph (1.0)	28		
8	Delay in move forward of enemy tps (relative to own troops):(2) - (1)	hrs (0.1) in(2)>(1)	1		
9	Overall duration of halts of enemy troops 'en route'	hrs (0.1)	0.5		
10	Overall delay of enemy troops by own troops	hrs (0.1)	0.6		
11	Speed of move forward of enemy tps	kph (1.0)	19		
12	(4) + (5) + (6)	(0.1)	0.3		
13	(12) x (7)	(0.1)	8.4		
14	(8) + (9) + (10)	(0.1)	2.1		
15	(14) x (11)	(1.0)	40		
16	(3) + (13) + (15)	(1.0)	153		

Ser No.	Starting Initial Determined Scales and Operations	Degree of Accuracy	Variant of Move Forward		
			Example	1	2
17	(7) + (11)	(1.0)	47		
18	Anticipated of contact/meeting (relative):(16):(17)	hrs (0.1)	3.3		
19	Duration of movement up to bound/ line of contact/meeting (18) - (12)	hrs (0.1)	3		
20	Distance of probable bound/line of contact/meeting:(19) x (7)	km (1.0)	84		

NOMOGRAM 10. Calculating the Commander and Staff's Working Time to Organise the Engagement of an Advancing Enemy.

To determine the time the commander and staff have available to organise the engagement of the advancing enemy requires the following data: the distance away of the enemy, the speed of his advance, the range of effective fire of own weapons and time necessary for the preparation of sub-units for firing. This is based on engaging the enemy at maximum range.

Formula of calculation:

$$t = \frac{(D - d) \times 60}{V_n} - t_g$$

where:

t = Time available to commanders and staff to organise the engagement of the advancing enemy in min.

D = Distance away of advancing enemy - km.

d = Maximum range of effective fire of own weapons - km.

60 = Coefficient of conversion of hours to minutes.

V_n = Speed of advancing enemy - kph.

t_g = Minimum warning time sub-units will need to prepare for engaging advancing enemy.

Example of calculation.

Determine how much time the commander and staff have at their disposal for organising the engagement of the advancing enemy, if he is 25km away and advancing at 15kph. Effective range of own weapons 12km, time subordinate sub-units need in order to get ready - 30m.

$$t = \frac{(25 - 12) \times 60}{15} - 30 = 22\text{mins}$$

Example of calculation using nomogram.

To determine the time available to the commander and staff to organise the engagement of the advancing enemy at a distance of 15km away, his speed of movement 12kph, effective range of own weapons 6km, warning time sub-units need to get ready - 20min.

Time available for work of commander and staff equals - 25min

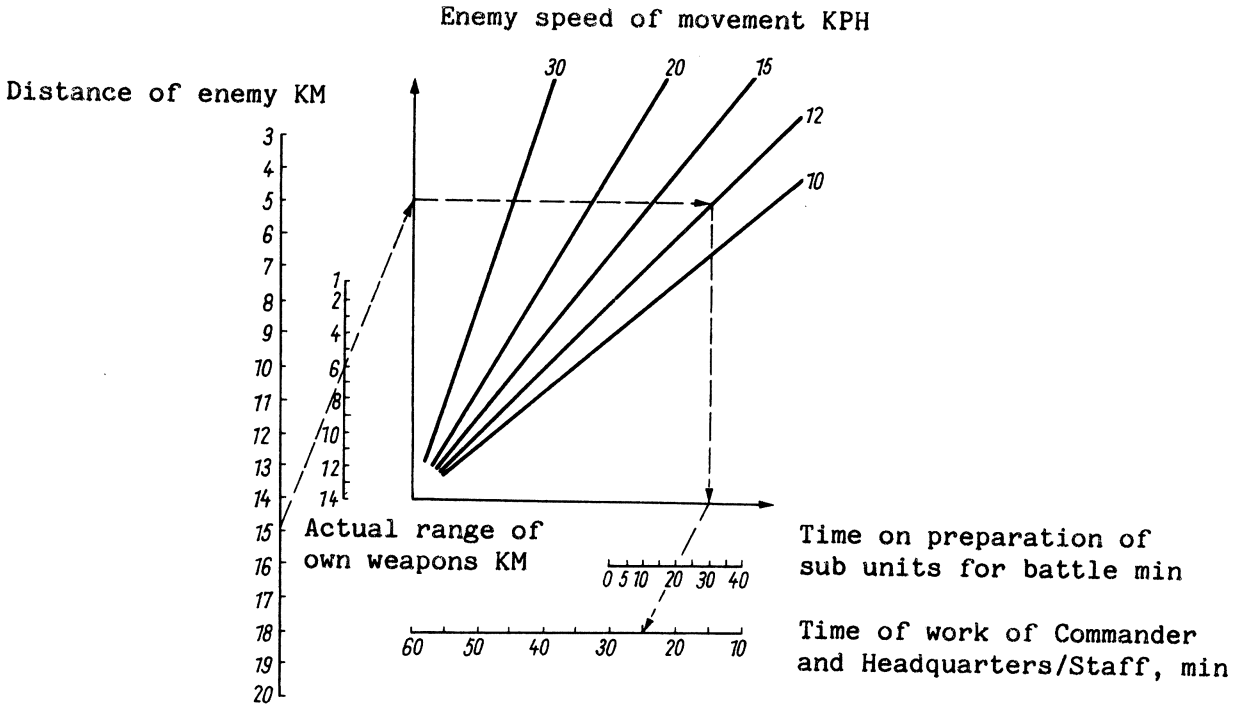


Figure 44. Nomogram for the Calculation Time Available to the Commander and Staff's for Organising for Battle with Advancing Enemy.

NOMOGRAM 11. The Anticipated Time and Speed of Catching Up in Pursuit of the Enemy.

The basic data needed for this calculation is, distance of the enemy from own troops, average speed of movement of own troops and the enemy and the period of time available in which to catch him up.

Formula of calculation:

$$t_d = \frac{D}{V_H - V_n}$$ (For determining the time of catching up)

$$V_H = \frac{D + t_d \times V_n}{t_d}$$ (For determing speed of catching up)

where:

t_d = Time of catching enemy - hrs.

D = Distance away of enemy - km.

V_H = Speed of pursuit of enemy - kph.

V_n = Speed of movement of enemy - kph.

Example of calculation.

1. To determine, within how much time own troops will catch up with the retreating enemy, if his is 20km away, his speed of movement is 10kph, and speed of pursuit by own troops is 25kph.

Solution:

$$t_d = \frac{20}{25 - 10} = \frac{10}{15} = 1.3\text{hrs} = 1\text{hr } 20\text{mins}$$

2. To determine the speed of pursuit needed in order to catch the enemy after 45mins at a distance of 15km when his speed of movement 12kph.

$$V_H = \frac{15 + 0.75 \times 12}{0.75} = 32\text{kph}$$

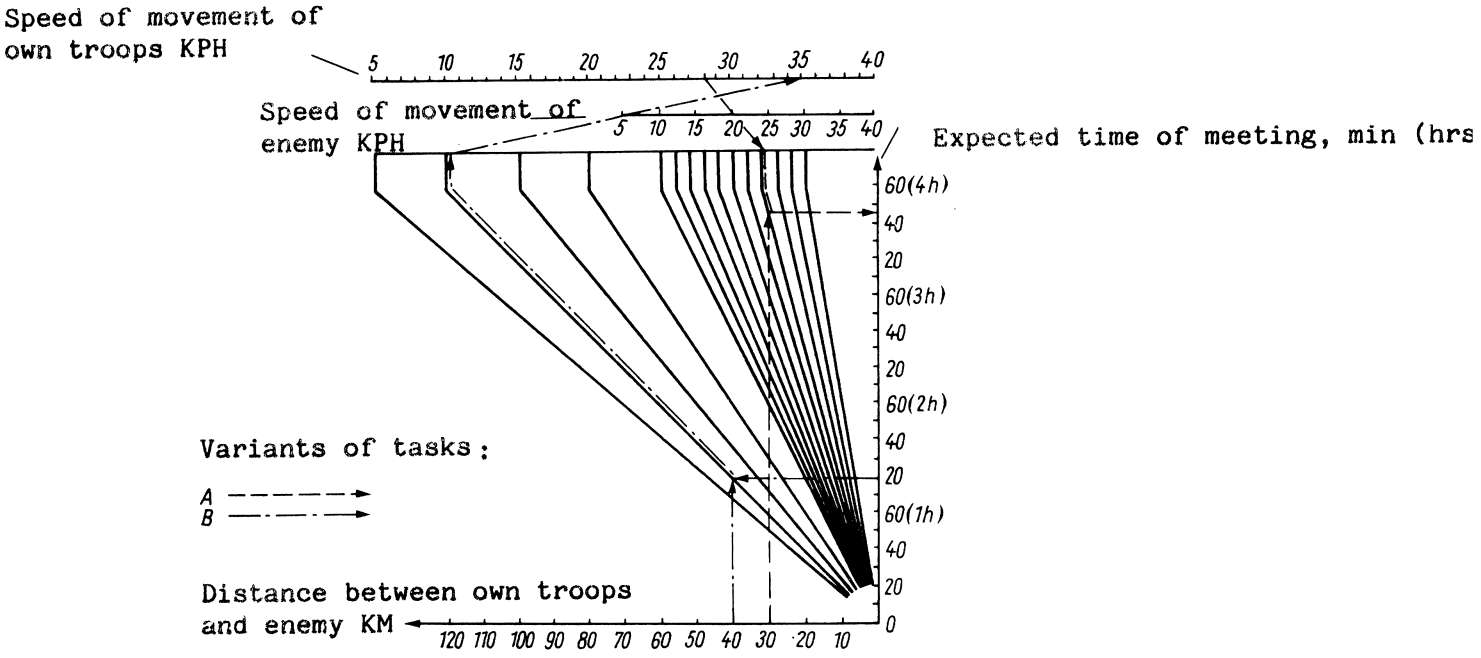


Figure 45. Nomogram for the Calculation of the Expected Time and Speed needed to Overtake in Pursuit of the Enemy.

To determine the expected time of catching up with the enemy if he is 30km away, his speed is 21kph and speed of own troops in pursuit is 28kph.

Variant a gives 3hrs 45mins.

3. To determine the required speed for overtaking and intercepting the enemy within 1hr 20mins. Distance away of enemy is 40km and his speed is 5kph.

Variant b gives 36kph.

NOMOGRAM 12. Expected Doses of Radiation of Personnel.

The basic data needed for this calculation is, the length/extent of the contaminated sector of the route, the average level of radiation on the route, the speed of movement of sub-units crossing the zone, the level of protection of personnel afforded by transport. With this method it is also possible to calculate the required speed for crossing a given zone so that personnel do not receive radiation doses higher than those authorised.

Formula of calculation:

1. Expected dose of radiation.

$$D = \frac{P \times L}{K \times V}$$

2. Required speed of movement.

$$V = \frac{P \times L}{K \times D}$$

where:

D = Expected dosage of radiation of personnel - R.

P = Average level of radiation on route - R/hrs.

L = Extent/length of contaminated sector of the route - km.

K = Coefficient of degradation of radiation depending on personnel protection factor.

V = Speed of movement in overcoming zone of radio-active contamination.

3. Average level of radiation on the route is determined on the basis of the data obtained by NBC reconnaissance.

Example of calculation by nomogram.

1. Determine the anticipated dose of radiation of personnel crossing a sector of radio-active contamination with the level of radiation at 60 R/hr, if the length of the contaminated sector of route is 12km, sub-unit speed 15kph, coefficient of degradation 2.

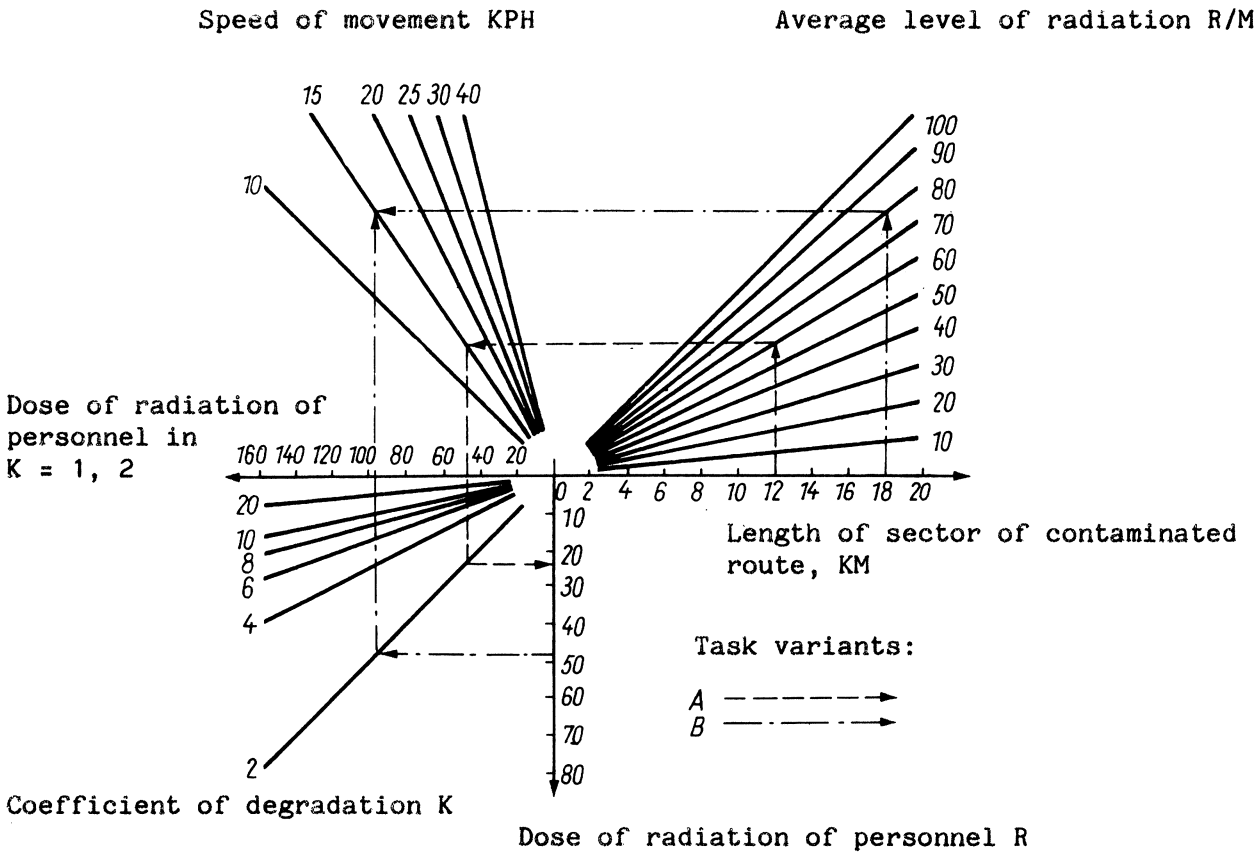

Speed of movement KPH
Average level of radiation R/M
15 20 25 30 40
10
100 90 80 70 60 50 40 30 20 10
Dose of radiation of personnel in K = 1, 2
160 140 120 100 80 60 40 20
0 2 4 6 8 10 12 14 16 18 20
Length of sector of contaminated route, KM
20 10 8 6 4 2
10 20 30 40 50 60 70 80
Task variants:
A
B
Coefficient of degradation K
Dose of radiation of personnel R

Figure 46. Nomogram for the Calculation of Radio-Active Contamination of Personnel Crossing a Zone of Radio-active Contamination.

Variant a gives 24 rontgens (R).

2. To determine the speed necessary to cross a contaminated zone so that personnel do not receive more than 48R. Conditions: extent of contaminated sector of route 18km, average level of radiation on route 80 R/hr, coefficient of radiation reduction/degradation (e.g. due to protection of vehicle).

NOMOGRAM 13. Graph for Calculating Required Number of Anti-Tank Weapons.

This graph has been combined with the following example to avoid duplication. Ed.

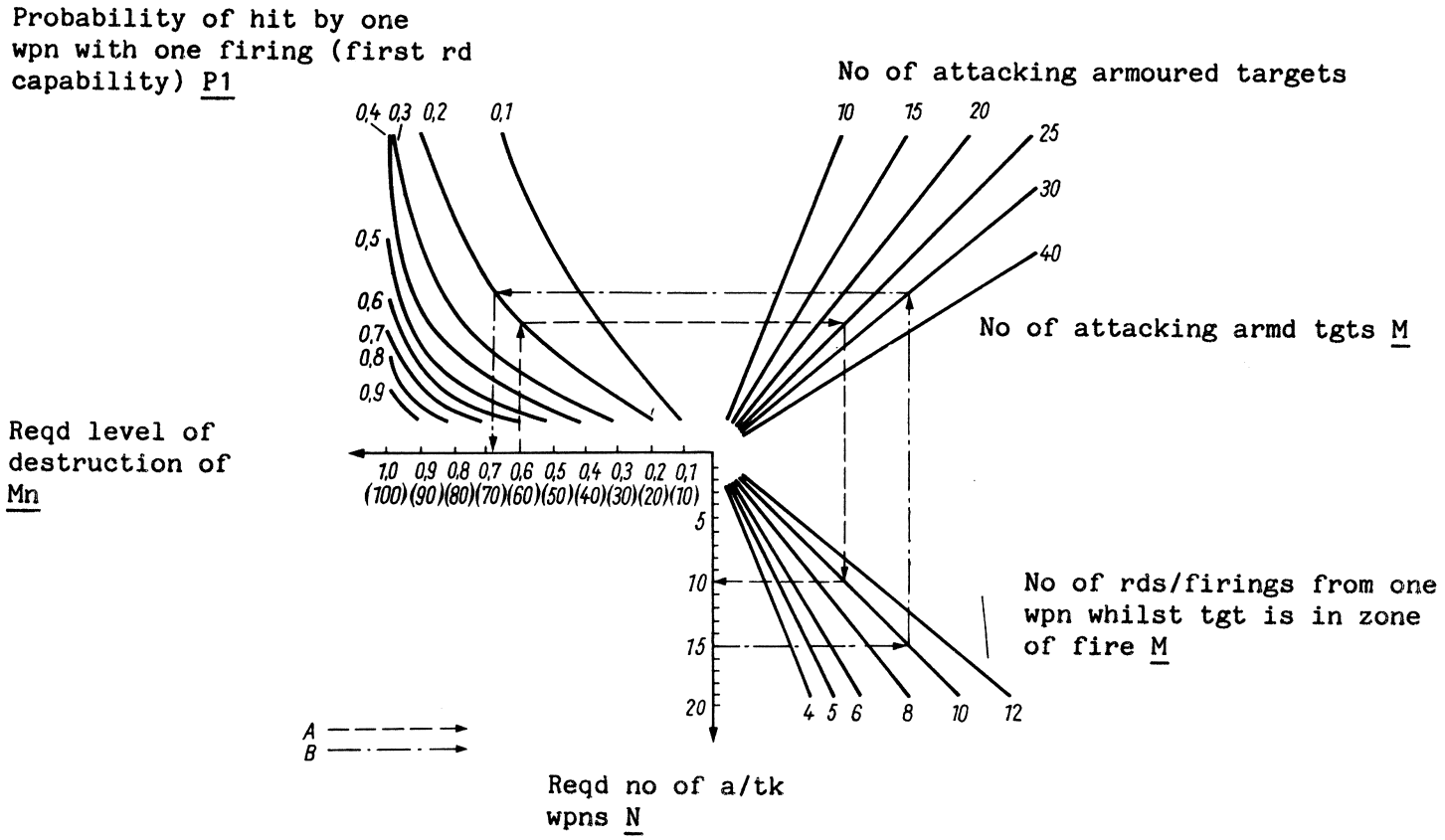

Probability of hit by one wpn with one firing (first rd capability) P1
0,4 0,3 0,2 0,1
0,5
0,6
0,7
0,8
0,9
No of attacking armoured targets
10 15 20 25 30 40
No of attacking armd tgts M
Reqd level of destruction of Mn
1,0 0,9 0,8 0,7 0,6 0,5 0,4 0,3 0,2 0,1
(100)(90)(80)(70)(60)(50)(40)(30)(20)(10)
5
10
15
20
No of rds/firings from one wpn whilst tgt is in zone of fire M
4 5 6 8 10 12
A
B
Reqd no of a/tk wpns N

Figure 47. Nomogram for Calculating Required Number of Anti-Tank Weapons.

NOMOGRAM 14. Determining of the Number of Different Weapons Needed for a Given Task and Their Effectiveness.

This method is intended for calculations for using weapons in attack or defence, and for using reconnaissance or communications means under different conditions. Initially the calculation is made for one type of weapon, determining its overall effectiveness or the overall general requirement in weapons or equipment. The data needed for this calculation is: the number of weapons available; the degree of fulfilment of the mission (e.g. the % of enemy vehicles to be destroyed, etc.); the effectiveness of the weapons to be used. The last is expressed by the probability of the degree of fulfilment of the task (P of K) or by the average factor of damage to the targetin question (a 'single weapon' is also taken to mean a group, of weapons amalgamated as a single target). Such data includes the probability of the destruction of the target, the extent of damage, inflicted on the target, the reliability of communications channels, the ability to detect an enemy target, the ability of ferries to keep crossing water obstacles in a set period of time, the probability of overcoming enemy air defences, etc. This data is obtained from exercise results and from statistical data of tactical and technical characteristics.

The formulae for calculating the degree of accomplishment of task by a given number of weapons is expressed as follows:

the probability of carrying out the task

$$P_n = 1 - (1 - P_1)^n$$

the mathematical expectancy (mean probability) of damage:

$$M_n = 1 - (1 - M_1)^n$$

where:

P_n = Probability of completion of task by a group of similar weapons.

P_1 = Probability of completion of task by one weapon.

M_n = Mean level of damage inflicted on the enemy by a group of weapons.

M_1 = Mean level of damage inflicted on the enemy by one weapon.

n = Number of available weapons.

$$P_n = 1 - (1 - P)^n$$

Probability of completion of tasks by group of similar weapons } = 1 - (1 - possibility of completion of task by one weapon)^(number of available weapons)

$$M_n = 1 - (1 - M_1)^n$$

Mean significance of damage inflicted on the enemy by group of weapons } = 1 - (1 - mean significance of damage inflicted on the enemy by one weapon)^(number of available weapons)

The formulae for the calculation of the necessary number of weapons, if the effectiveness of the weapons is expressed: by the likely degree of probability in carrying out the task:

$$n = \frac{\lg (1 - P_n)}{\lg (1 - P_1)} \quad \text{where } P_n > P_1:$$

by the mathematical expectancy (mean significance) of the inflicted damage:

$$n = \frac{\lg (1 - M_n)}{\lg (1 - M_1)} \quad \text{where } M_n > M_1$$

The for the calculating of the effectiveness of hetereogenuous weapons which are to carry out the general task:

$$P_n = 1 - (1 - P_1) \times (1 - P_2) \times (1 - P_i)$$

where:

P_n = degree of fulfilment of task

P_1, P_2, P_i = effectiveness of weapons, which are to be allotted for the accomplishment of the task.

Example of calculation.

Determine the probability of detecting an enemy object by combined use of three means of reconnaissance, if their effectiveness, expressed in the probability of detecting the enemy object is:

$$P_1 = 0.4;\ P_2 = 0.6;\ P_3 = (0.8)$$

Solution:

$$Pn = 1 - (1 - 0.4) \times (1 - 0.6) \times (1 - 0.8)$$

$$= 1 - (0.6 \times 0.4 \times 0.2)$$

$$= 1 - 0.0048$$

$$= 0.95$$

That is probability of detecting an enemy object by these given means of reconnaissance/detection is virtually absolute.

From the example it can be seen that the probability of carrying out the task, grows with the increase in the number of means used, but not in direct proportion.

Examples of the calculations using nomograms (see Figure 48.).

1. Determine the probability of destruction of an enemy object by a strike by three weapons, if the probability of destruction of the object by one weapon of a given type equals 0.4.

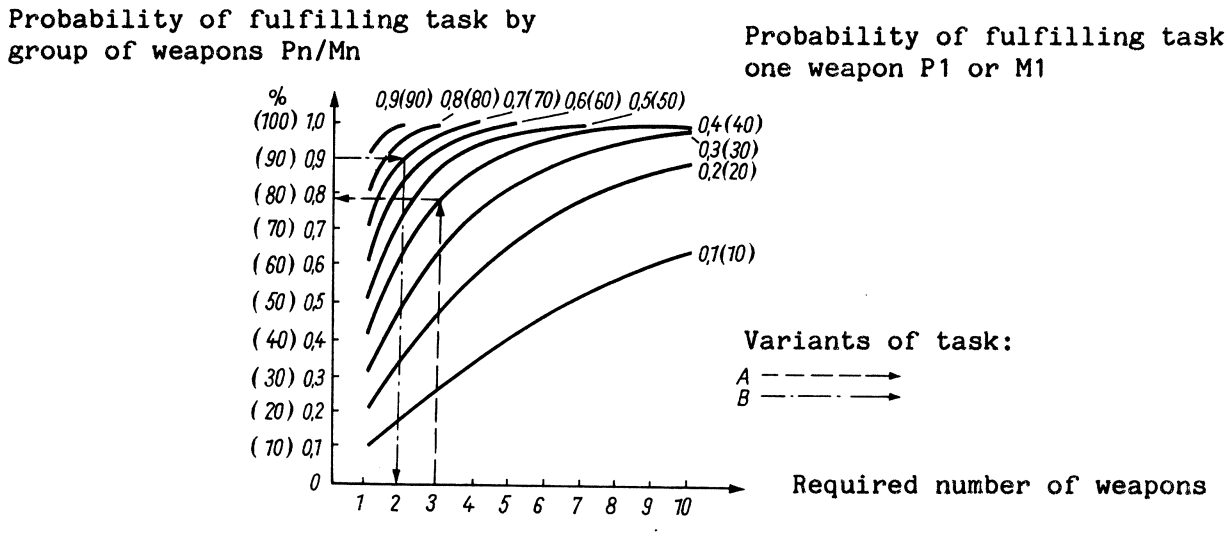


Figure 48. Nomogram for the Calculation of the Detail Necessary in the Evaluation of the Effectiveness of Several Weapons of the Same Type.

From the mark - "3" (variant a) on the scale "required number of weapons draw vertically up to the intersection with the curve". "Probability of fulfilling the tasks by one weapon" - "0.4". From the point of intersection draw a horizontal line and read off on the scale "Probability of fulfilling the task by a group of weapons".

Solution: the probability of destruction of an object by these weapons is 0.78 (78%).

By a similar calculation it is possible to determine the reliability of communications in a link which is made up from two channels (n = 2), if the reliability of each channel equals 0.6. According to the nomogram the probability of good communications on a given link would be 0.84 (84%).

Evaluate the effectiveness of using 4 similar means to locate of an enemy object in a given area, if the probability of detection by one means equals 0.5 (50%). According to the nomogram the probability of detection of the object would be near to absolute - 0.94 (94%).

2. Determine how many weapons are necessary to inflict damage of not less than 90% on an enemy object, if the average damage, inflicted by one weapon equals 70%.

From the mark "0.9 (90%)" on the scale "Probability of carrying out the tasks by a group of weapons" draw a horizontal line to the intersection with the curve "Probability of carrying out the task by one weapon" - 0.7 (70%).

From the point of intersection draw a vertical line to the scale "Required number of weapons" - the result is 2. That is, for the attainment of the required damage, two weapons are needed.

In a similar manner it is possible to determine the necessary number of communications channels to guarantee 90% reliability of communication, if the reliability of each channel is 0.6 (60%).

According to the nomogram for guaranteeing communications with the required reliability no less than three channels are necessary.

From the above examples, it is evident that this method can be used for the calculation of a wide variety of direct and indirect tasks.

The formula of the calculation of the effectiveness of forces and weapons (means) taking account of likely enemy counter-action is:

$$P_n = 1 - (1 - P_1 \times Q)^n \quad \text{or} \quad M_n = 1 - (1 - M_1 \times Q)^n$$

where:

P_n = Probability of accomplishment of tasks by a group of weapons (means).

P_1 = Probability of accomplishment of task by one weapon (means) of a given type.

Q = Probable index of enemy counter-action.

n = Number of forces and weapons of a given type to be used.

M_n = Mathematical expectancy (mean average) damage inflicted by a group of weapons (means) of a given type.

M_1 = Mathematical expectancy (mean average) of damage inflicted by one weapon (means) of a given type.

$$P_n = 1 - (1 - P_1 \times Q)^n$$

Probability of accomplishment of task by group of weapons } = 1 - (1 - (Probability of accomplishment of task by one weapon of a given type) x (Probable index of enemy counter-action))^(Number of weapons of a given type)

$$M_n = 1 - (1 - M_1 \times Q)^n$$

Mathematical expectancy of damage inflicted by a group of weapons of a given type } = 1 - (1 - (Mathematical expectancy of damage by one weapon of a given type) x (Probable index of enemy counter-action))^(Number of weapons of a given type)

Example of Calculation.

Determine the probability of accomplishing a task by five weapons if the probability of destruction/damage of the target by one weapon is 60% (0.6), but the probability of enemy counter-action (damage by the enemy of our weapons) is 50% (0.5).

Solution:

$$P_n = 1 - (1 - 0.6 \times 0.5)^5 = 1 - (1 - 0.3)^5 = 1 - (0.7)^5 = 1 - 0.17 = 0.83$$

Solution - 83% probability.

Proforma No 5. The Determination of the Required Amount of Manpower and Weapons for Bringing Sub-Units up to Scale in the Restoration of their Battle Worthiness.

This calculation is made so as to establish how many men and weapons are needed to restore the sub-unit to battle worthiness. It is not envisaged that the refurbishment restores the sub-unit to its original establishment, but just to the necessary ratio of superiority of forces and weapons between the two sides.

The basic data needed for the calculation is information on the original full strength of the troops of the two sides, the losses sustained and the superiority ratio of manpower and weapons required for carrying out the task. The results of the calculation represent numbers necessary to restore to battle worthiness.

The formula of the calculation is:

$$M_i = C_i - \frac{A_i}{B_i} \; ; \; A_i = (n_c - n_c \times P_c) \times N_c$$

$$B_i = (n_n - n_n \times P_n) \times N_n \; ; \; m_i = B_i \times M_i$$

where:

M_i = The index of the reduction of battle worthiness resulting from the required ratio of manpower and weapons for the execution of the task.

C_i = The required level of superiority ratio for a particular type of weapon.

A_i = The availability of a number of weapons of a particular type of own forces.

B_i = The availability of a number of weapons of a particular type of enemy forces.

n_c (n_n) = The initial full strength of own troops (enemy troops) by type of weapons - pers/proportions.

P_c (P_n) = Losses of own troops (enemy troops) - pers/proportions.

N_c (N_n) = The establishment number of weapons of a particular type of own forces (enemy forces).

m_i = The number of weapons of a particular type which are required for the restoration of own troops battle worthiness.

$$M_i = C_i - A_i$$

$$\frac{}{B_i}$$

Index of reduction/lowering of battle worthiness = {Required level of superiority ratio for a particular type of weapon} - {Available number of weapons of a particular type - own troops / available number of weapons of a particular type - enemy troops}

$$A_i = (n_c - n_c \times P_c) \times N_c$$

Available number of weapon of a particular type - own forces = (Initial strength* own troops - initial strength* own troops x own troops Losses) x {Establishment number of personnel/weapons

---

* Weapons.

$$B_i = (n_n - n_n \times P_n) \times N_n$$

Available number of weapons of a particular type - enemy forces = (Initial strength (enemy forces - initial strength enemy forces x Losses enemy troops) x {Establishment number of personnel/weapons

$$m_i = B_i \times M_i$$

Number of weapons of a particular type needed for restoration of own troops battle worthiness = Available number of weapons of a particular type enemy forces x The index of reduction of battle worthiness below the required ratio of manpower and weapons for the execution of the task

In $M_i < 0$ the calculation is not taken further, for in such an occasion the resupply of manpower and forces for the restoration of battle fitness is not required.

This method can be used both to calculate the number of different types of weapons and to calculate a general quantitative-qualitative factor.

Example of calculation using the proforma.

Determine the required number of tanks and guns to re-equip a sub-unit if the required level of superiority is 2.5:1, the initial full strength of own troops was 85% (0.85), losses of own forces in tanks 40% (0.4), the initial full strength of the enemy was 60% (0.6), his losses in tanks 40% (0.4). Producing the calculation according to the proforma we find that to resupply the sub-unit and restore of battle worthiness requires 2 tanks. Replacements of guns are not required since, given the losses on both sides, the required level of superiority necessary for the execution of the task is preserved.

Table 106. Proforma for the Calculation of the Required Amount of Personnel and Equipment for the Replenishment of Sub-Units and the Restoration of Their Battle Fitness.

Ser No.	Starting Data Determined Scales and Operations	Degree of Accuracy	Forces and Equipment				Remarks
			Tanks	Guns	Mortars	Btr	
1	Initial full strength of own troops	%	0.85	0.7			Example of calc by the proforma
2	Casualties of own troops	%	0.4	0.2			To determine the required
3	Organic number of equipments of own troops	single	25	32			number of tanks and guns for the replenish-
4	(1) x (2)	(0.01)	0.34	0.14			ment of a sub- unit if the set
5	(1) - (4)	(0.01)	0.51	0.56			level of supe- riority is 2.5
6	(3) x (5)	(1.0)	13	18			from a full strengh of own
7	Initial full strength of enemy troops		0.6	0.6			forces of 85% (0.85), losses
8	Casualties of enemy troops	%	0.4	0.3			of own troops in tanks 40%
9	Organic number of equipments of enemy troops		18	25			(0.4); enemy forces full stength 60%
10	(7) x (8)	(0.01)	0.24	0.18			(0.6) his cas- ualties in tanks 40%
11	(7) - (10)	(0.01)	0.36	0.42			(0.4). Accord- ing to the pro-
12	(9) - (11)	(1.0)	6	10			forma we find the replenish-
13	The established level of superiority of own troops (deduced from relationship of forces and equipments)		2.5	1.5			ment of the sub-unit and restoration of battle worthi- ness requires 2
14	(6):(12)	(0.01)	2.17	1.8			tanks.

Ser No.	Starting Data Determined Scales and Operations	Degree of Accuracy	Forces and Equipment				Remarks
			Tanks	Guns	Mortars	Btr	
15	(13) - (14)*	(0.01)	0.33	-0.3			
16	Number of equipments necessary for the replenishment: (12) x (15)	(1.0)	2	-			

---

* In (15) < 0 the replenishment of forces and equipments is not required, the sub-unit is battle worthy and is able successfully to fulfil the given task beforehand.

Appendix 3 to Annex E

NOMOGRAM 15. Duration of a Crossing with one Ferry.

The duration of a 'wave' * is dependent on the character of the water obstacle and the ferrying equipments and furthermore the time required for loading and unloading equipment and cargo from the ferry.

The basic data required for the calculation is the width of the water obstacle, speed of the current, speed of movement of the ferrying means (swimming) and; time necessary for the loading and unloading of equipment or cargo.

In method of calculation:

$$t = \frac{2D\ (1 + 0.3\ V_B)}{V} + t_l$$

where:

t = Duration of one 'wave' of ferrying means - min.

D = Width of water obstacle - m.

V = Ferry speed - m/min.

V_B = Speed of current - m/sec.

t_l = Time necessary for loading/unloading.

Example of calculation.

To determine the duration of a "wave" of ferries swimming speed 8kph

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* A "wave" is the term used to describe a single passage across a water obstacle by one or by a group of several items of amphibious assault equipment (ferry, APC, etc.).

(133m/min) if the width of the water obstacle is 360m, current speed 2.5m/min, duration of loading/unloading 12min.

Solution:

$$t = \frac{2 \times 360}{133} (1 + 0.3 \times 2.5) + 12 = 22\text{mins}$$

Example of calculation using nomogram.

To determine the duration of a crossing, swimming speed 9.5kph (160 m/min) if the width of the river is 250m, speed of current 2m/sec, time for loading/unloading 6 minutes.

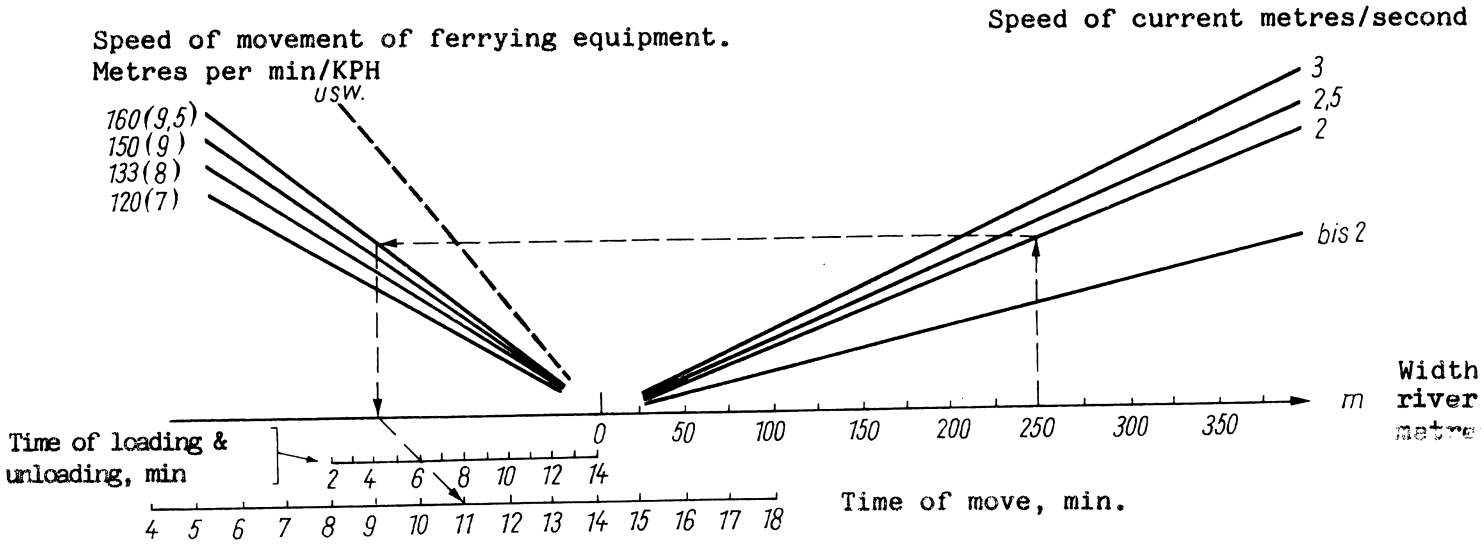

Figure 49. Nomogram for the Calculation of the Duration of a Crossing with One Ferry.

The nomogram gives 11mins as duration of a crossing.

Further calculations can be made to determine the overall time of a crossing. As in the example the overall time on the given sector (if for the operation 15 crossings are required) = 11mins x 15 = 165mins = 2hr and 45mins.

NOMOGRAM 16. Duration of Water Crossing of Tanks in a Deep Ford or Submerged (Schnorkelling).

The basic data needed for the calculation is: the number of tanks to cross; the established time for the crossing, and; the width of the river and time of the day.

Formula of the calculation:

Duration of tank water crossings:

$$t = \frac{(D + N \times d) \times 0.06}{V \times n}$$

Number of tanks in a given time:

$$N = \frac{t \times V \times n - 0.06D}{0.06d}$$

where:

t = Duration of tanks crossing - min.

D = Width of river or length of underwater track.

N = Number of tanks.

d = Distance between vehicles.

0.06 = Coefficient converting kph into m/min.

Example of calculation.

1. Determine the duration of a water crossing of 18 tanks on one path across a water obstacle of 280m in width, interval between vehicles 60m, swimming speed 8kph.

Solution:

$$t = \frac{(280 + 18 \times 60) \times 0.06}{8} = 10\text{min}$$

2. To determine how many tanks can cross a river 360m wide in 25mins on one path, if the speed of the tanks 6kph and distance between vehicles 120m.

Solution:

$$N = \frac{25 \times 6 - 0.06 \times 360}{0.06 \times 120} = 18 \text{ tanks}$$

Examples of calculation usng nomogram.

1. To determine the duration of a crossing of 15 tanks, underwater on one path at night across a water obstacle 300m wide. Solution: (variant a) - 18mins.

2. To determine how many tanks can cross under water a river 250m wide, by day, on one path, in 15 minutes. Solution: (variant b) - 25 tanks.

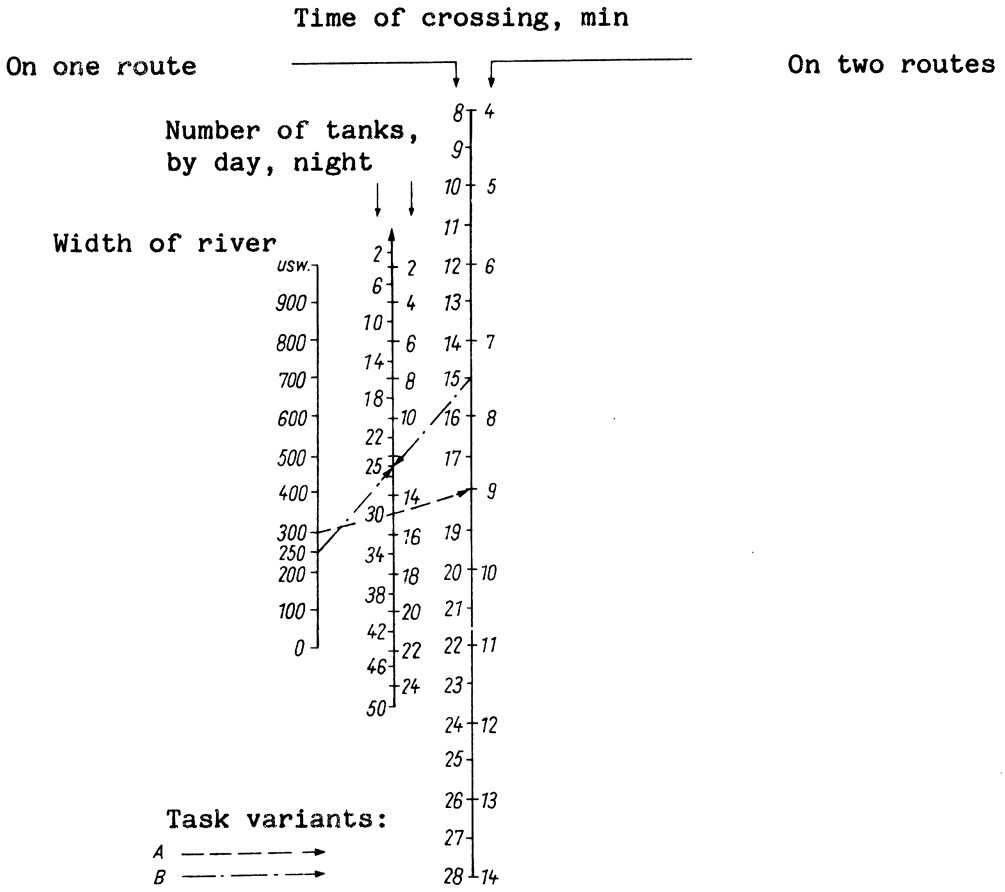

Figure 50. Nomogram for the Calculation of Tanks Crossing Underwater.

NOMOGRAM 17. Duration of a Water Crossing.

This is the method for establishing the duration of a forced crossing by amphibious assault equipments. The basic data needed for the calculation is: the required number of crossing points; the number of amphibious equipments, and; the duration of one wave.

Formula of calculation:

$$t = \frac{M \times t_p}{N}$$

where:

t = Duration of the crossing - mins.

M = Required number of waves.

t_p = Duration of one wave.

N = Allotted number of amphibious assault equipments.

Example of calculation.

Determine the duration of a crossing of 168 vehicles in 84 vehicles "waves", the duration of each "wave" is 15mins, for each crossing 24 amphibious equipments are allocated.

$$t = \frac{84 \times 15}{24} = 52 \text{ mins}$$

Example of calculation by nomogram.

1. To determine the duration of crossing of equipment if 88 vehicle waves are required, duration of one wave 12 mins, number of ferring equipments 15.

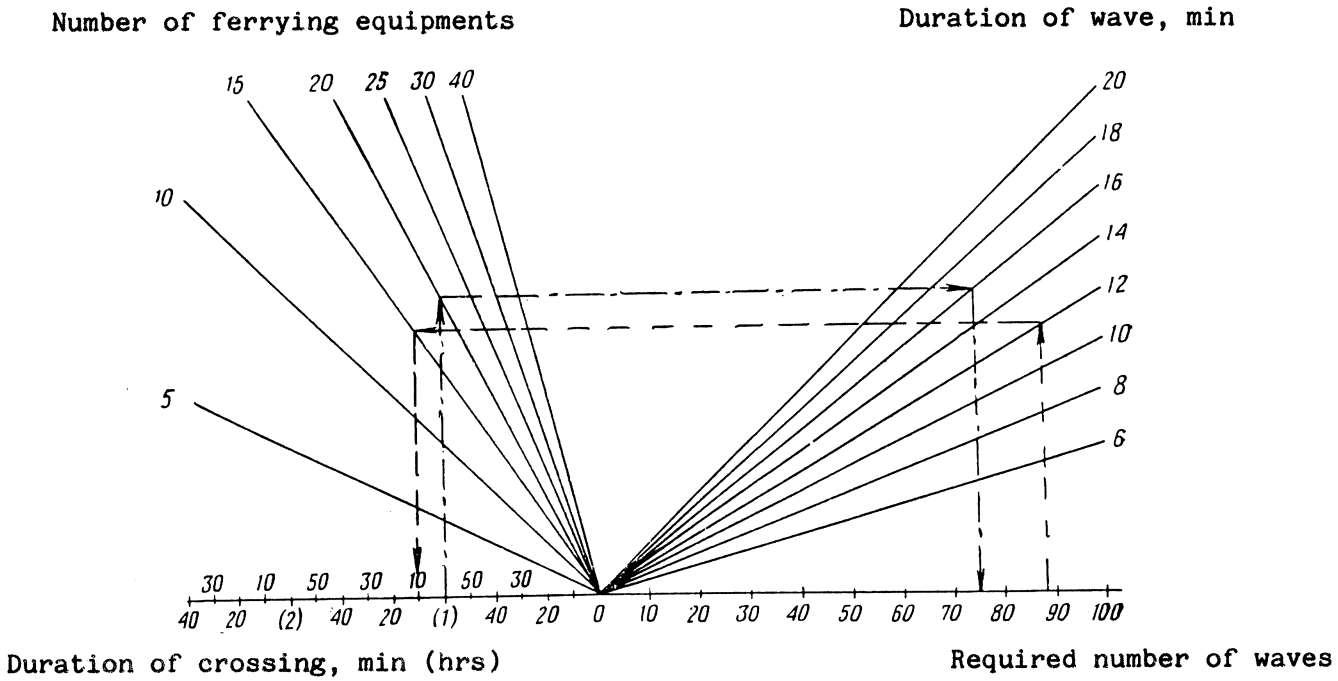

Figure 51. Nomogram for the Calculation of the Duration of a Water Crossing.

Solution: (variant a) - 1hr 10mins.

2. On the nomogram it is possible to solve an inverse task. To determine the total duration of the crossing if the durationof each wave is 16mins, number of ferrying equipment 20 and each ferrying equipment carries one vehicle.

Solution: (variant b) - 75 vehicles per hour.

NOMOGRAM 18. Calculation of the Number of Mines for the Construction of a Mine Obstacle.

The basic data needed for the calculation is the extent of the line/feature, which it is necessary to cover with an established density of mining, with an available number of mines and the density of the obstacles necessary on a given feature.

Formula of calculation:

1. Required number of mines:

$$N = D \times P \times n$$

2. Extent covered by the obstacles on the feature:

$$D = \frac{N}{P \times n}$$

3. Density of obstacle:

$$P = \frac{N}{D \times n}$$

where:

N = Required number of mines for the construction of the obstacles.

D = Front of feature, which is to be covered by mines.

P = Density of obstacle (extent of minefield - 1km).

n = Density of mining (number of mines in 1km).

Example of calculations.

1. Determine the required number of mines for obstacles on a feature 9.6km with a density of obstacles 0.85 (850m of obstacles on 1km of frontage of the protected feature) with a density of mining 750 mines on 1km of

minefield.

Solution:

$$N = 9.6 \times 0.85 \times 750 = 6120 \text{ mines}$$

2. Determine the extent of a feature which it is possible to protect by obstacles having availabile 2850 mines. The required density of obstacles 0.75, i.e. density of mining 750 mines in 1km of minefield.

Solution:

$$D = \frac{2850}{750 \times 0.75} = 5\text{km}$$

3. Calculate the density of obstacles on a feature of 7.5km long, if the expenditure of 4780 mines in a density of mining 800 mines per 1km of minefield.

Solution:

$$P = \frac{4760}{7.5 \times 800} = 0.8$$

Examples of calculation using nomogram.

1. To determine the required number of mines for the protection by mined obstacles of a feature 6.5km long, if the obstacle density is 0.6 and the density of mining 700 mines to 1km of front.

Solution: (variant a) - 2730 mines).

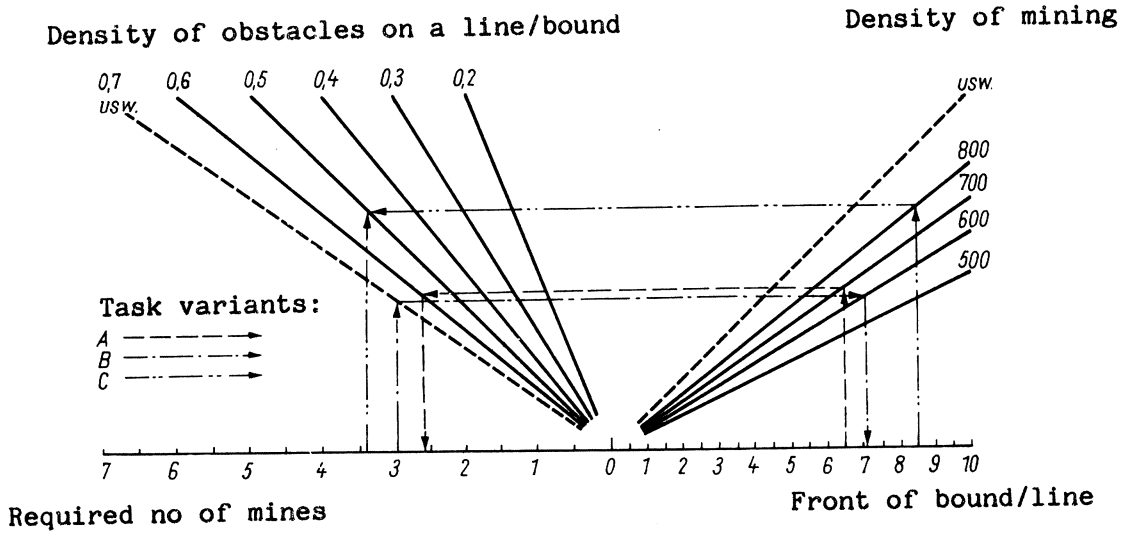

Figure 52. Nomogram for the Calculation of the Required Number of Mines in Constructing a Minefield Obstacle.

2. Determine the length of a feature, which is to be protected by minefield obstacles with an availability of 3000 mines, if the density of mining is 600 mines on 1km of minefield, obstacle density 0.7.

Solution: (variant b) - a frontage of 7.1km.

3. Calculate the density of obstacles on a feature 8.5km long, if 3400 mines are to be expended in a density of mining 800 mines to 1km of minefield.

Solution: (variant a) - 0.5km of obstacles on 1km of the protected feature.

Table 107. Proforma for the Calculation of Manpower and Equipment, Necessary for the Construction of an Engineer Fortification on the Ground.

Ser No.	Designated Constructions	Number of Constr-uction	Norms on Construction		Man Days (3)* x (4)	Machine Hours (3) x (5)	Remarks
			Man Days	Machine Hours			
1	2	3	4	5	6	7	8
1	Single track for riflemen	128	0.15	-	19.2	-	Example of calc by proforma
2	Sector trenches	6	10.5	-	63	-	To determine the required no
3	MG trenches	15	0.25	-	3.75	-	of manpower and equipment for
4	10m trenches	20	1.2	-	24	-	the erection in two days of
5	Gunpit - 100mm gun	-	4	0.5	-		the following fortifications
6	Gunpit - 122mm	3	4.5	0.7	13.5	2.1	- see column 3.
7	Gunpit - 120mm Mor	3	3.5	-	10.5	-	The ordered for -tifications
8	Pit for BTR	18	0.2	1.0	3.6	18	require 222.45 (~223) men days
9	Pit for tank	-	1.1	1.4	-	-	and 27.5 machine hours
10	Op	5	0.5	-	2.5	-	of earth moving equipment.
11	Open slit trench	3	1.0	-	3	-	The number of personnel which
12	Covered trench-section	4	3.5	-	14	-	are required in the course of 2
13	Shelter	4	12.3	-	49.2	-	days consist of 223:2 ~ 112

See also Annex H for detail of norms.

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* Figures in brackets

Ser No.	Designated Constructions	Number of Constr-uction	Norms on Construction		Man Days (3)* x (4)	Machine Hours (3) x (5)	Remarks
			Man Days	Machine Hours			
1	2	3	4	5	6	7	8
14	Cover for GAZ-69, GAZ-66	6	1.2	0.5	7.2	3	men; Besides one bulldozer is required
15	Cover for ZIL-157	4	1	0.6	4	2.4	since 30.5 / 2.20 = 1
16	Cover for BTR	5	1	0.4	5	2	
17	In all in lines (6) and (7)	-	-	-	222.45	27.5	

* Figures in brackets

Table 108. Proforma for the Calculation of the Duration of a River Crossing of Sub-Units on Amphibious Assault Equipment.

Ser No.	Starting Data Determined Scales and Operations	Degree of Accuracy	Calculation Variant				Remarks
1	Number of tanks to be found on GSP	single (1.0)	16				Example of calculation by the proforma. To determine the duration of a crossing of sub-units, consisting if 34 tanks and 67 vehicles, with the allotted number of amphibious assault equipment: (GSP-3, PTS-4, ferries 3). Capacity of ferries 1 x tank or 4 x wheeled vehicles. By calculation overall ferrying time - 2hrs but duration of tank ferrying serial (16) - 1.5hrs
2	Number of tanks to be found on ferries	single (1.0)	18				
3	Number of wheeled vehicles to be found	single (1.0)	67				
4	Number of GSP	single (1.0)	3				
5	Number of PTS	single (1.0)	4				
6	Number of ferries	single (1.0)	3				
7	Capacity of ferries (according to wheeled vehicles)	single (1.0)	4				
8	Duration of wave GSP	min (1.0)	13				
9	Duration of Wave PTS	min (1.0)	12				
10	Duration of wave - ferries	min (1.0)	15				
11	(1) x (8)	(10)	210				
12	(11):(4)	(10)	70				
13	(2) x (10)	(10)	270				
14	(13):(6)	(10)	90				
15	To select the greater: (12) or (14)	(10)	90				

Ser No.	Starting Data Determined Scales and Operations	Degree of Accuracy	Calculation Variant				Remarks
16	Duration of ferrying the tanks: (15):60	hrs (0.1)	1.5				
17	(5) x 60	(1.0)	240				
18	(17):(9)	(1.0)	20				
19	(18) x (16)	(1.0)	30				
20	(3) - (19)	(1.0)	37				
21	(6) x ( )	(1.0)	12				
22	(21) x 60	(1.0)	720				
23	(23):(10)	(1.0)	48				
24	(23) + (18)	(1.0)	68				
25	(20):(24)	(0.1)	0.5				
26	Overall duration of ferrying (16) + (25)	has (0.1)	2.0				

Note: In the (20) < the calculation ends, since the overall time of the crossing is equal to the time of ferrying the tanks.

Appendix 4 to Annex E

NOMOGRAM 19. Engagement of Personnel and Weapons by Artillery Fire *.

The data for the calculation consists of:

a. Number of guns and their calibre (also mortars).

b. Characteristics of the target (area of target).

c. Level of protection of personnel and weapons in the target area.

d. Fire mission - (destruction, neutralisation).

e. Planned duration of fire.

The formula of calculation.

$$S_i = \frac{N_i \times n_i}{m_i}$$

where:

S_i = Area in hectares for the engagement of personnel and weapons.

N_i = Number of guns/mortars and calibre.

n_i = Number of rounds per gun/mortar per min dependent on max, permitted rates of fire.

m_i = Density of rounds per hectare.

Example of calculation.

Determine the area of neutralisation of personnel and weapons by a fire mission of 18 x 122mm How for a duration of 5 minutes, if each gun

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* Takticheskiye Raschety, p50/51.

according to the maximum permitted rates of fire in that time fires 25 rounds, the required rounds on 1 hectare = 8 rounds.

$$S = \frac{18 \times 25}{80} = 5.6 \text{ hectares}$$

Examples of calculation according to the Graph.*

1. To determine the effective fire probability of 12 x 122mm Hows in the neutralisation of personnel in the open for 15 minutes.

On the graph with the "dashed red line" from the point "15" minutes on the "duration of fire" scale go upwards until the dashed red line nears the maximum permitted rates of fire curve for 122mm How. From this point follow the dashed red line horizontally across to where it cuts the "number of guns - 12" line. Then follow the dashed red line downwards until it cuts 122mm line - troops in open. From here horizontally across to where it cuts the area in number of hectares line at 33**.

2. Determine the duration of fire by 12 122mm How on personnel in the open, area 20 hectares. Solving the task - from point 20 on area of "engagement" scale go horizontally across to where it cuts 122mm How line - "troops and weapons in the open" - then go vertically upwards number of guns - 12 - then go horizontally to where the line cuts the line ("maximum permitted rates of fire 122mm How") - from this intersection down vertically to the duration of fire scale in minutes - the result is 7 mins.

3. To determine how many 100mm guns and ammunition are required for the neutralisation of a hastily occupied strongpoint - area 7.2 hectares for 10 minutes.

From line at point "10 min duration" of this scale go upwards to

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* Takticheskie Raschetii, p51.

** This line should cut exactly on 33. But error can caused by improper curve between 10 and 20 mins on maximum permitted rates of fire graph on incorrect reproduction of 'Quantity' of guns required - 12 guns.

where it intersects "maximum permitted rates of fire" curve for 100mm gun. From there left horizontally. From the point 7.2 hectares in area of "engagement" scale go horizontally left to where it cuts 100mm gun on "unobserved protected personnel and weapons" scale and further vertically to where it cuts the "number of guns required" - 36 scale. The point where this line crosses the "amount of ammunition required scale" is 1800 rounds.

NOMOGRAM 20. Duration of Fire Without a Change of Gun Position.

Formula of Calculation:

$$t = \left(\frac{D - d}{V_B} - \frac{D - d}{V_{cm}}\right) \times 60 - tc$$

or

$$t = (D - d)\left(\frac{1}{V_B} - \frac{1}{V_{cm}}\right) \times 60 - tc$$

where:

t = Duration of fire without a change of gun positions or time on one position - mins.

D = Actual distance of effective fire - km.

d = Established distance of gun position from the forward line of own troops - km.

V_B = Speed of advance of own troops - kph.

V_{cm} = Speed of guns/weapons in moving positions - kph.

60 = Coefficient from hours to minutes.

t_c = Time allowed for vacating position/occupying position.

Example of calculation.

To determine the duration of fire from mortars without moving positions if:

distance of position from front own troops - 3km - d

actual distance of effective fire - 7.5km - D

speed of advance own troops - 5km - V_B

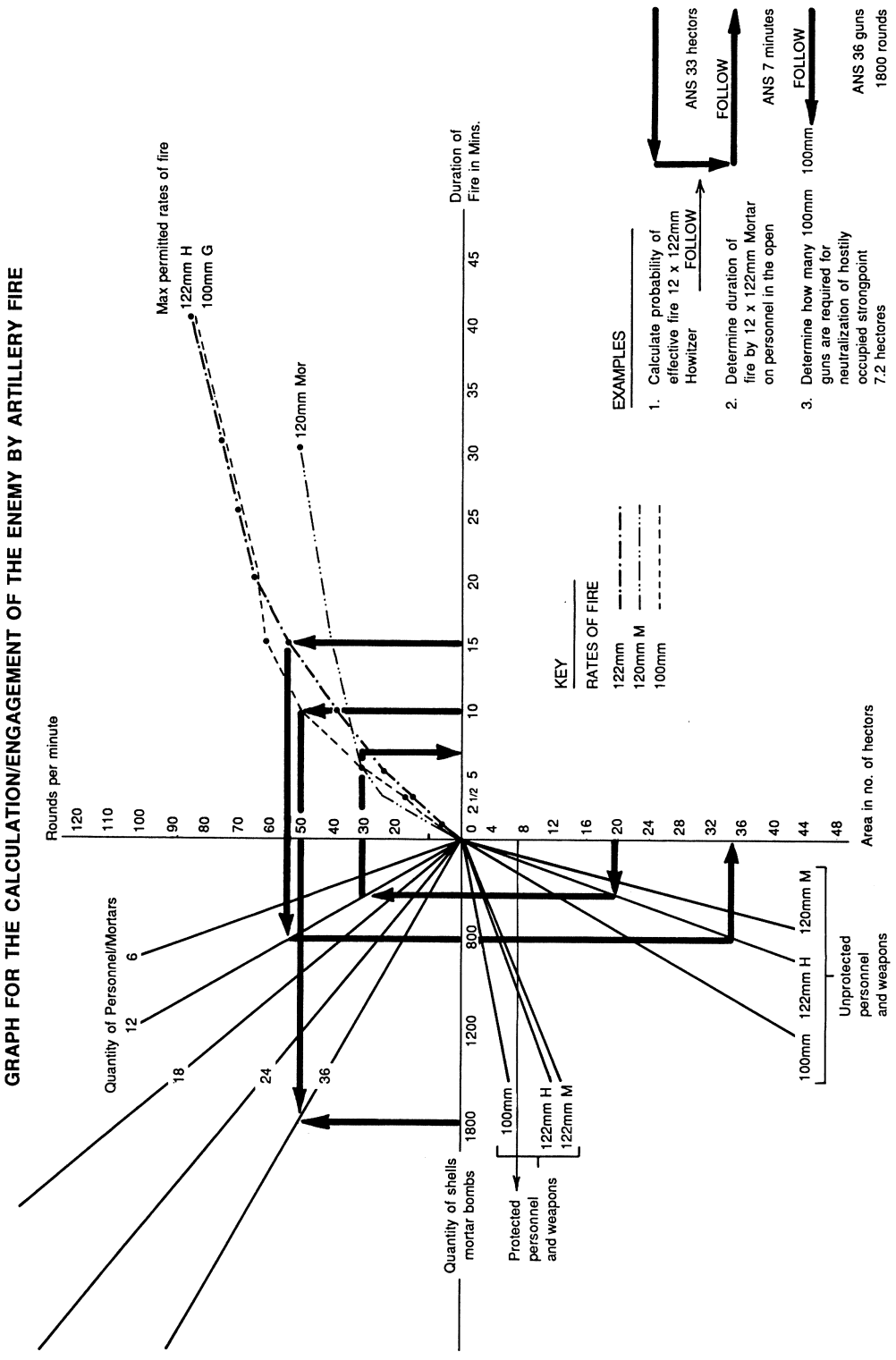

GRAPH FOR THE CALCULATION/ENGAGEMENT OF THE ENEMY BY ARTILLERY FIRE
Max permitted rates of fire
122mm H
100mm G
120mm Mor
Duration of Fire in Mins.
Rounds per minute
Quantity of Personnel/Mortars
Quantity of shells mortar bombs
Protected personnel and weapons
Unprotected personnel and weapons
Area in no. of hectors
KEY
RATES OF FIRE
122mm
120mm M
100mm
EXAMPLES
1. Calculate probability of effective fire 12 x 122mm Howitzer FOLLOW ANS 33 hectors FOLLOW
2. Determine duration of fire by 12 x 122mm Mortar on personnel in the open ANS 7 minutes
3. Determine how many 100mm guns are required for neutralization of hostily occupied strongpoint 7.2 hectores FOLLOW 100mm ANS 36 guns 1800 rounds

Figure 53. Graph for the Calculation/Engagement of the Enemy by Artillery Fire.

speed of sub-units in moving position - 25kph - V_{cm}

time of for vacating/occupying positions - 15mins - t_c

$$t = \left(\left(7.5 - 3\right) - \left(7.5 - 3\right)\right) \times 60 - 15$$
$$\left(\frac{}{5} - \frac{}{25}\right)$$

$$= \left(\frac{4.5}{5} - \frac{4.5}{25}\right) \times 60 - 15$$

$$= (0.9 - 0.18) \times 60 - 15$$

$$= 0.72 \times 60 - 15$$

$$= 43 - 15$$

$$= \underline{28\text{mins}}$$

Range of mortars.

Example of calculation according to graph using Figure 54.

1. Determine the actual firing time of guns on one fire position if:

distance of position from front own troops - 6km - d

actual distance of effective fire - 14km - D

speed of advance own troops - 6kph - V_B

speed of sub-unit in moving positions - 15kph - V_{cm}

2. It is necessary to determine the difference between D and d. This is 8km. On both "firing range less distance own troops" scales make a mark at distance 8. From 'B' on the lower scale draw vertically to "speed of advancing sub-units - 6". From 8 on the upper scale we draw another perpendicular to "15 - on fire weapons speed line".

From both points of intersection draw horizontal lines to scales I

and II. From scale I draw a line writing scale II (where horizontal from "15" on fire weapons speed cuts) through to "duration of time of guns/weapons on position". From this we read off - 48 minutes. However for 'out of a crisis' and occupation of said position allow 20 minutes, therefore length of time on gun position cannot be more than 28 minutes.

A quick check with the formula gives us 28 minutes - see working below:

D = 14km

d = 6km

V_B = 6kph

V_{cm} = 15kph

t_c = 20min

$$t = \left(\frac{(D - d)}{V_B} - \frac{(D - d)}{V_{cm}}\right) \times 60 - 20$$

$$= \frac{14 - 6}{6} - \frac{14 - 6}{15} \times 60 - 20$$

$$= \frac{8}{6} - \frac{8}{15} \times 60 - 20$$

$$= 1.33 - 0.53 \times 60 - 20$$

$$= 48 - 20 = 28\text{mins}$$

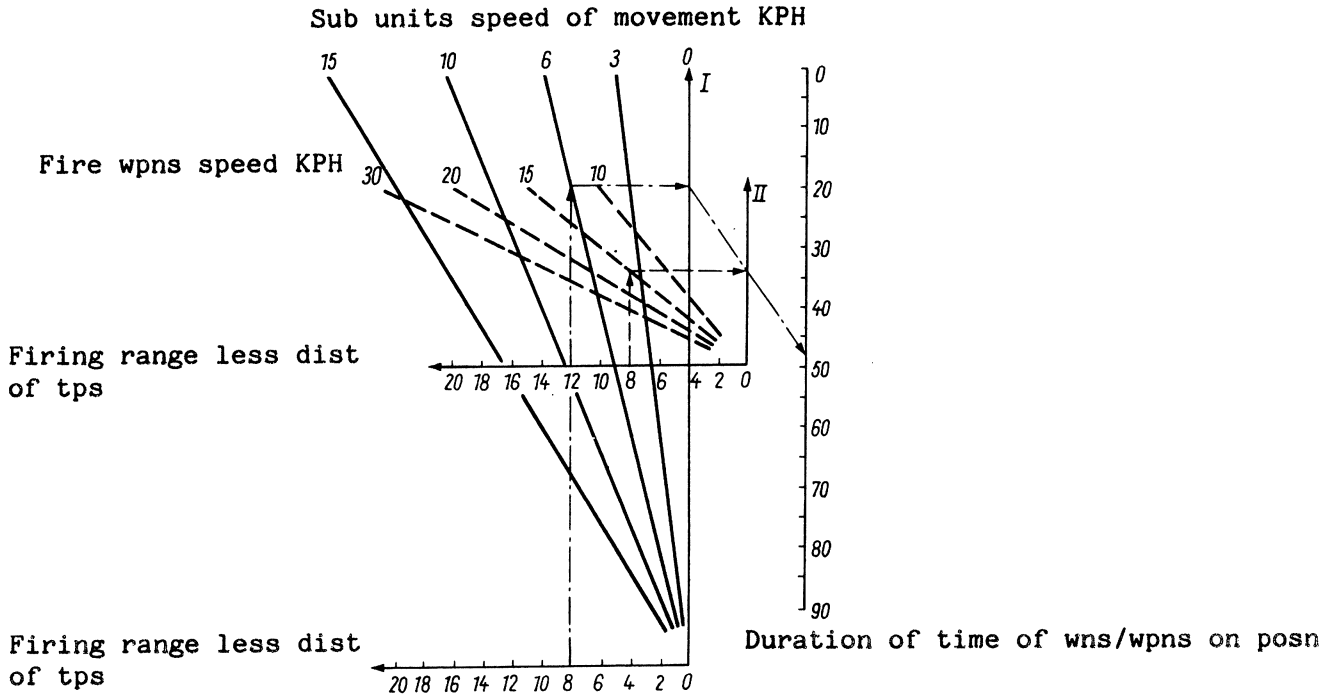


Figure 54. Duration of Fire Without Changing own Position.

NOMOGRAM 21. Time Spent in Changing Gun Position.

Formula of calculation:

$$t = \frac{60 \times D}{V} + t_1 + t_2$$

where:

t = Time spent in changing positions - mins.

60 = Coefficient hours to minutes.

D = Distance away of new position - km.

V = Speed of movement during change - kph.

t_1 = Time spent vacating position.

t_2 = Time spent occupying new position.

Example of formula.

To determine the time spent in changing positions if:

$D = 15\text{km}$

$V = 35\text{kph}$

$t_1 = 12\text{min}$

$t_2 = 15\text{min}$

$$t = \frac{60 \times 15}{35} + 12 + 15 = 53\text{mins} \ (52.71\text{mins})$$

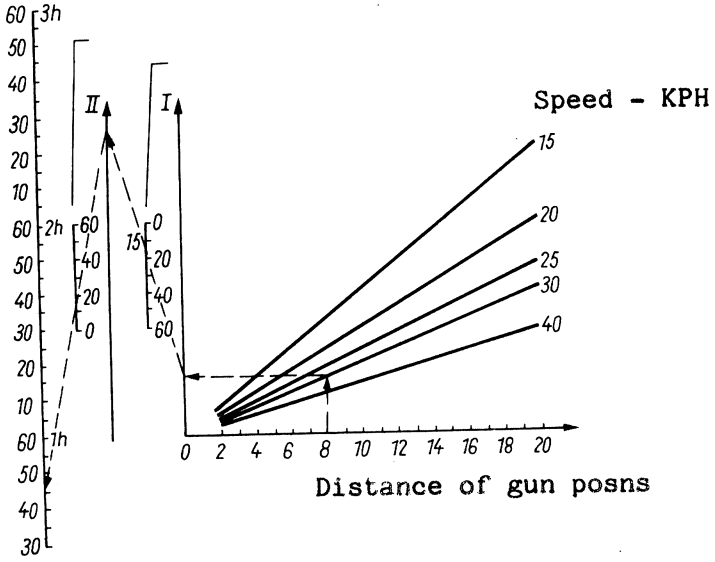
Example by graph using Figure 21.

D = 8km

V = 30kph

t_1 = 15min

t_2 = 15min



Time spent in changing gun positions

Figure 55. Time Spent in Changing Gun Position.

Proforma No 7. Calculation of the Fire Capabilities of Artillery.

The method for the determination of the overall area of engagement of enemy personnel situated in the open by the available number of guns (mortars) comes from a planned duration of fire.

The data for the calculation is the information about the number and type of guns (mortars) allotted for the engagement, depending on the rate of fire of a given type of gun or mortar.

The formula of calculation:

$$S = \sum_{i=1}^{n} \frac{N_i \times n_i}{m_i}$$

where:

S = The overall area of engagement of the enemy with a determined number of guns and mortars in a set time - hectares.

N_i = The number of allotted guns (mortars) of a particular type.

n_i = The number of shells (bombs) fired by one gun (mortar) of a particular calibre in a set time of firing - shells.

m_i = The number of shells (bombs) required for the necessary engagement of the enemy on one hectare of the target.

In the calculation the calculating proforma (Table 109) is used.

Table 109. Proforma for the Calculation of Artillery Capability.

Ser No.	Starting Data Determined Scales and Operations	Degree of Accuracy	Calculation Variant			Remarks
			Example	1	2	
1	Number of 122mm guns	single (1.0)	18			
2	Number of rounds expended during the fire mission (intense)	shell (1.0)	40			10mins. Rounds per gun. 4 rounds per min
3	Number of 100mm guns	single (1.0)	12			
4	Number of rounds expended during the fire mission (intense)	shell (1.0)	50			
5	Number of 120mm mortars	single (1.0)	12			
6	Number of bombs expended during the fire mission (intense)	bomb (1.0)	35			
7	(1) x (2)	(1.0)	720			
8	(7):20	(0.1)	36			
9	(3) x (4)	(1.0)	600			
10	(9) x 30	(0.1)	20			
11	(5) x (6)	(1.0)	420			
12	(11):60	(0.1)	42			
13	Overall area of engagement of the enemy (8) + (10) + (12)	hectares (1.0)	98			

Ser No.	Starting Data Determined Scales and Operations	Degree of Accuracy	Calculation Variant		Remarks
			Example	1 / 2	
Example of Calculation according to the proforma					
To determine the fire capabilities of artillery in engaging enemy personnel situated in the open by a 10 minute fire strike/mission. For the engagement 18 x 122mm How, 12 x 100mm gun and 12 x 120mm Mortars are allotted. During the course of the fire mission 40, 50 and 35 rounds will be fired respectively*. According to the proforma the overall area of enemy personnel to be engaged within a 10 minute fire strike is 98 hectares.					

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* Per gun.

Appendix 5 to Annex E

Proforma No 9. Number of Aircraft (Helicopters) for the Transportation of Loads.

The basic data needed for the calculation is the mass of the transportable loads, their transportability, the useful load capacity of the aircraft (helicopters) allotted for the transportation, length of air route, speed of the flight, and furthermore the time, necessary for technical maintenance, refuelling and rest of crews between sorties.

Formula of the calculation:

$$N_P = \frac{P \times K}{q} \; ; \; t_P = \frac{2D}{V} + t_{pass} \; ; \; K_P = \frac{T}{t_P} \; ; \; n = \frac{N_P}{K_P}$$

where:

N_P = Required number of aircraft (helicopters) sorties for transportation of loads (ordered op).

P = Overall mass of loads - tons.

K = Coefficient of load transportability in relation to the useful load carrying capacity of the aircraft (helicopters). The size of K is always greater or equal to 1. For example if the utilisable load carrying capacity of an aircraft is 8 tons, then into it, it is possible to load only 5 tons of cargo (because of its character, dimensions, volume - of the load and dimension of the airforce), then the coefficient of transportability of a given type of aircraft will by 8:5 = 1.6.

q = The useful load carrying capacity of the aircraft (helicopter) in given circumstances - ton.

t_P = Duration of one sorties - hours.

D = Range of transportation - km.

V = Average speed of flight - kph.

t_{pass} = Dead time (average time, necessary for loading, carloading, technical maintenance, refuelling, etc. for one sortie).

K_P = Number of sorties, which may be undertaken by aircraft in a laid down time (ordered down).

T = Laid down time.

N = Required number of aircraft (helicopters) of transportation of loads in a given period (ordered op).

Table 110. Proforma for the Calculation of the Required Number of Aircraft (Helicopters).

Ser No.	Starting Data Determined Scales and Operations	Degree of Accuracy	Calculation Variant			Remarks
			Example	1	2	
1	Overall mass of loads	T (0.1)	38			
2	Coefficient of transportability	(0.01)	1.5			
3	Load carrying capacity of aircraft	T (0.1)	12			
4	Length of flight	km (10)	820			
5	Speed of flight	kph (10)	700			mph 437.50
6	Waiting time	hrs (0.1)	3			Example of calculation by proforma. To determine the no of aircraft for the transportation of 38 tons if the useful load carrying capacity of the aircraft is 12 tons the coefficient of transportability of loads is 1.5, length of the route is 820km, average speed of flight is 700kph, dead time 3 hrs. Time of transportation is established as 6hrs. Conducting the calculation we detemine that for the fulfilment of the task in the laid time in the given conditions demands 5 aircraft.
7	Established time of transportation	hrs (0.1)	6			
8	(1) x (2)	(0.1)	57			
9	(8):(3) (awarded up to larger)	(1.0)	5			
10	(4) x (2)	(10)	1640			
11	(10:(5)	(0.1)	2.3			
12	(11) + (6)	(0.1)	5.3			
13	(7):(12) (awarded down)	(1.0)	1			
14	Required number of aircraft (9):(13) (awarded up)	single (1.0)	5			

Proforma No 10. Calculation of the Duration of Transportation of Loads by a Given Number of Vehicles.

Formula of Calculation:

$$N_P = \frac{P \times K}{q} \; ; \; t_p = \frac{2D}{V} + t_{n \times B} + t_{pass} \; ; \; K_P = \frac{N_P}{N} \; ;$$

$$T = K_P \times t_p \; ; \; T_1 = T - \left(\frac{D}{V} + t_{pass}\right)$$

where:

N_P = Required number vehicle sorties.

P = Overall mass of loads to be transported - tons.

K = Coefficient of transportability of loads.

q = Load carrying capacity of vehicles - tons.

t_p = Duration of one sortie - hours.

D = Range of transportation - km.

V = Average speed of vehicle movement - kph.

$t_{n \times B}$ = Duration of loading/unloading of vehicles - hours.

t_{pass} = Dead time (time for refuelling, technical maintenance, deivers rest period after each sortie).

K_P = Number of sorties for each vehicle.

N = Available nominated number of vehicles.

T = Duration of transportation of loads with return of transport.

T_1 = Duration of transportation of loads without return of transport.

Table 111. Proforma for the Calculation of the Duration of Transportation of Loads by a Given Number of Vehicles.

Ser No.	Starting Data Determined Scales and Operations	Degree of Accuracy	Calculation Variant			Remarks
			Example	1	2	
1	Overall mass of transportable loads	T (0.1)	38.5			Example of calculation by proforma.
2	Coefficient of load transportability	(0.01)	1.5			To determine the duration of transporting 38.5T by 12 vehicles with load capacities of 3T over a distance of 85km if the coefficient of transportability is 1.5, speed of movement of the vehicle transport is 25kph, duration of loading/unloading is 30min, dead time 1hr. Deducting the calculation according to the proforma, we find that under the given conditions in the transportation of loads with a return of vehicles requires 16.6hrs. in order to calculate the time of transportation without the return of the vehicles from the time (16.6) we deduce the duration of the return and dead time, i.e. $16.6-\left(\frac{85}{25}+1\right)=16.6-(3.4+1)=16.6-4.4$
3	Vehicle load capacity	T (0.1)	3			
4	Length of transportation	km (1.0)	85			
5	Speed of movement of vehicle transport	kph (1.0)	25			
6	Duration of loading/unloading	hrs (0.1)	0.5			
7	Dead time (drivers rest, refuelling, etc.)	hrs (0.1)	1			
8	Available quantity of vehicles	single (0.1)	12			
9	(1) x (2)	(0.1)	57.8			
10	(9):(3) rounded up	(1.0)	20			
11	(4) x 2	(1.0)	170			
12	11):(5)	(0.1)	6.8			
13	(12) + (6) + (7)	(0.1)	8.3			
14	(10:(8) rounded up	(1.0)	2			

Ser No.	Starting Data Determined Scales and Operations	Degree of Accuracy	Calculation Variant			Remarks
			Example	1	2	
15	Duration of transportation with the return of the motor transport (14) x (13)	hrs (0.1)	16.6			= 12.2hrs
16	(4):(5) + (7)	(0.1)	4.4			
17	Duration of transportation without the return of the motor transport (15) - (16)	hrs (0.1)	12.2			

Proforma No 11. For the Calculation of the Necessary Amount of Transport for Moving Loads in a Set Time.

Formula for Calculation:

$$N_P = \frac{P \times K}{q} \; ; \; t_p = \frac{2D}{V} + t_{n \times B} + t_{pass} \; ; \; K_P = \frac{T}{t_p} \; ; \; N = \frac{N_P}{K_P}$$

where:

N_P = Required number of vehicle sorties.

P = Overall mass of load - tons.

K = Coefficient of transportability.

q = Load carrying capacity of vehicles - tons.

t_p = Duration of one sortie - hours.

D = Range of transportation - km.

V = Average vehicle speed of movement - kph.

t_{nB} = Time of loading/unloading.

t_{pass} = Dead time.

K_P = Number of sorties in a laid down time.

T = Laid down time of transportation - hours.

N = Required number of vehicles.

Table 112. Proforma for the Calculation of the Necessary Amount of Transport for the Transportation of Loads in a Set Time.

Ser No.	Starting Data Determined Scales and Operations	Degree of Accuracy	Transportation Variant			Remarks
			Example	1	2	
1	Overall mass of trans-portable load	T (0.1)	42.5			Example of calculation by proforma.
2	Coefficient of load transportability	(0.01)	1.25			To determine the required number of vehicles for the transportation of 42.5T over a distance of 65km with 14.5hrs, if the coefficient of transpor-tation of load is 1.25 speed of movement of transport is 30km, load carrying capacity of vehicles is 2.5T, duration of loading/ unloading is 30min, dead time on each sortie 2hrs.
3	Vehicle load carrying capacity	T (0.1)	2.5			
4	Length of transporta-tion	km (1.0)	65			
5	Speed of movement of transport	kph (1.0)	30			
6	Duration of loading/ unloading (per sortie /wave)	hrs (0.1)	0.5			
7	Dead time per sortie (driver rest, refuel-ling)	hrs (0.1)	2			
8	Set time for transpor-tation	hrs (0.1)	14.5			
9	(1) x (2)	(0.1)	52.1			
10	(9):(3) rounded up	(1.0)	22			
11	(4) x 2	(1.0)	130			
12	(11):(5)	(0.1)	4.3			
13	Duration of one sortie (6) + (7) + (12)	hrs (0.1)	6.8			

Ser No.	Starting Data Determined Scales and Operations	Degree of Accuracy	Transportation Variant			Remarks
			Example	1	2	
14	(8):(13) rounded down	(1.0)	2			
15	The required amount of transport (10):(14) rounded up	(1.0)	11			

Proforma No 12. For Calculation of Time Taken to Transport Sub-Units by Rail.

Formula for calculation:

$$t = \left(\frac{D}{V} + \frac{N-1}{n}\right) \times 24 + \frac{D_1}{V_1} + \frac{D_2}{V_2} + t_0$$

where:

t = Time of troop transportation by rail - hours.

D = Length of railway route - km.

V = Average train speed - kpm.

N = Number echelons to be transported.

n = Rate of transportation (from loading conditions and character of railway route), trains - 24 hours.

24 = Coefficient of conversion 24 periods to hour.

D_1 = Distance of FUP/concentration area to station - km.

V_1 = Average speed of movement from concentration area to station - kph.

D_2 = Distance from unloading station to new concentration area - km.

V_2 = Average speed of movement to new concentration area from unloading station - kph.

t_0 = Time in organising transportation - hours.

Table 113. Proforma for the Calculation of the Duration of Transporting Sub-Units by Rail Transport.

Ser No.	Starting Data Determined Scales and Operations	Degree of Accuracy	Calculation Variant			Remarks
			1	2	3	
1	Length of rail route	km (10)				
2	Average speed in 24hr period	km/24hrs (10)				
3	Number of transported echelons reduced to a single unit	single (1.0)				
4	Rate of transportation	single (1.0)				
5	Distance of FUP from loading area (station)	km (1.0)				
6	Average speed of movement to loading area	kph (1.0)				
7	Distance of new concentration area from unloading point (station)	km (1.0)				
8	Average speed of movement to new area	kph (1.0)				
9	Time on organising transportation	hr (1.0)				
10	(1):(2)	(0.01)				
11	(3):(4)	(0.01)				
12	(10) + (11)	(0.01)				
13	(12) x 24	(1.0)				

Ser No.	Starting Data Determined Scales and Operations	Degree of Accuracy	Calculation Variant			Remarks
			1	2	3	
14	(5):(6)	(0.1)				
15	(7):(8)	(0.1)				
16	Time taken to transport of troops by rail: (13) + (14) + (15) + (9)	hrs (1.0)				
17	Time of transportation (16):24	24hrs periods (0.1)				

NOMOGRAM 22. Traffic Carrying Capacity of a Route.

Calculation of the traffic carrying capacity of routes takes into account: the quality of the road, type of movement of transport and conditions of movement.

The basic data required for the calculation is speed of movement of transport, distance between vehicles, character of movement, one or two lane, the coefficient of the reduction of the traffic carrying capacity taking into account movement in columns, and coefficients, allowing for the interaction on the route of railway lines of different capacities.

Formula of Calculation:

$$N = \frac{V \times q \times k}{d \times K} \times 1000$$

where:

N = Traffic carrying capacity of road, vehicle per hour.

V = Speed of movement - kph.

q = Coefficient, taking into account the influence of returning movement in a two lane movement (1.6).

k = Coefficient, taking into account the intensity of train movement (30 steam trains in 24hrs - 0.75; 40 - 0.65; 50 - 0.57; 60 - 0.5; 70 - 0.4).

K = Coefficient of lowering the traffic capacity taking into account of movement in columns in speeds of 10kph - 2.8; 20kph - 2.4; 25kph - 2.2; 30kph - 2; 40kph - 1.8; 50kph - 1.6.

1000 = Coefficient of converting km to m.

Example of calculation.

Determine the traffic capacity of a section of route given that permitted speed - 30kph, two lane movement, distance between vehicles 75m, route is cut by a railway main line with an intensity of movement 50 steam trains in 24 hours.

Solution:

$$N = \frac{30 \times 1.6 \times 0.57}{75 \times 2} \times 1000 = 182 \text{ vehicles in one hour}$$

Reducing the distance between vehicles to 25m increases the traffic capacity to 546 vehicles per hour. Without the railway crossing then under the same conditions the traffic carrying capacity is increased to 960 vehicles per hour.

Examples of calculation using nomogram.

1. To determine the traffic carrying capacity of a road with single lane movement if the permitted speed is 40kph and 30m between vehicles.

Variant a gives 740 vehicles per km.

If it is necessary to include the effect of a railway on the above example with, say, a rail intensity of 40 steam trains per 24 hours then the vehicle carrying capacity drops to 480 per km.

2. Determine what interval between vehicles is required to achieve 400 vehicles per km if the permitted speed on a single lane road is 30kph, with a railway crossing with 30 trains in 24 hours.

Solution: (variant b) - not more than 28m between vehicles.

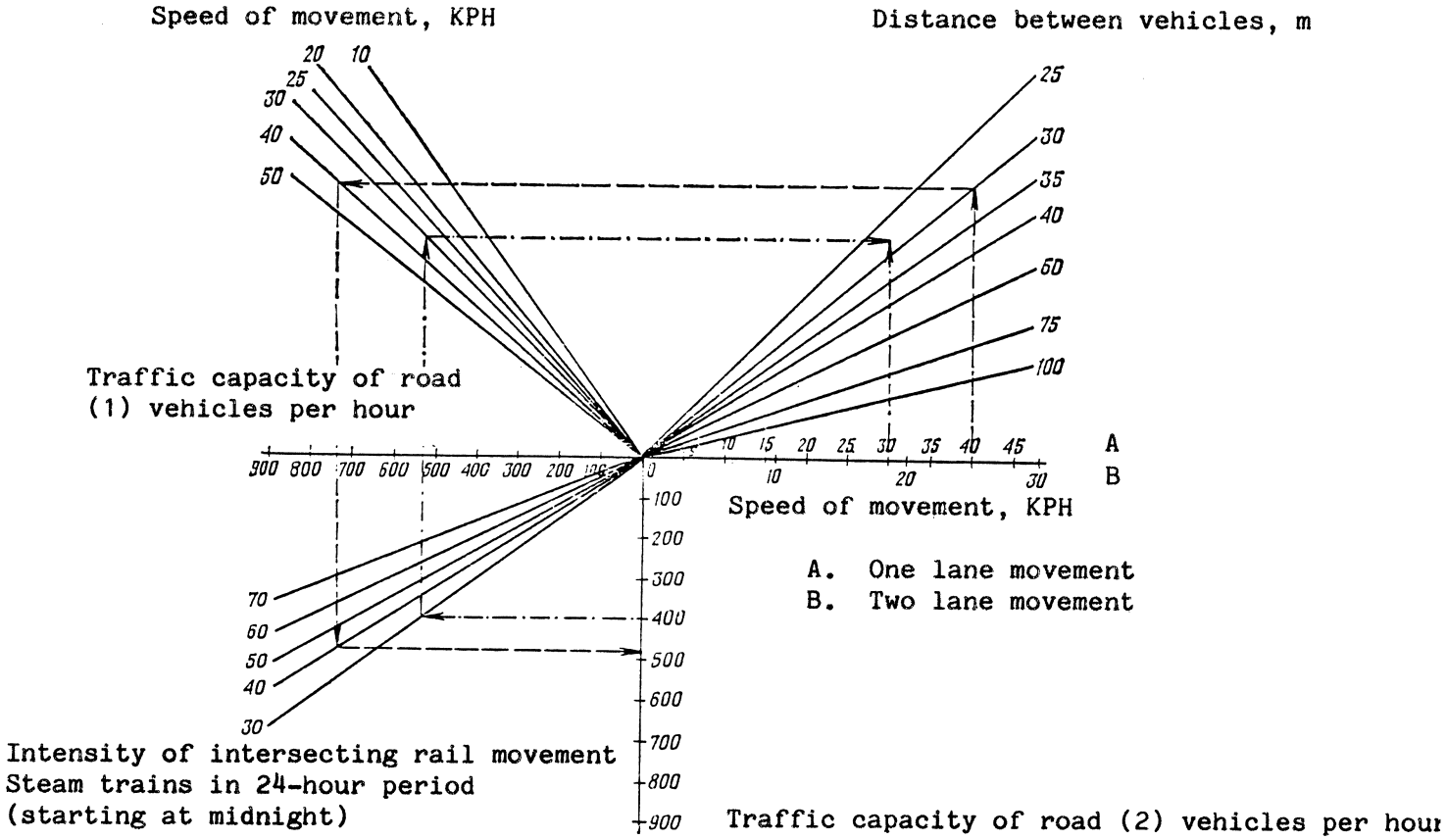

Figure 56. Nomogram for the Calculation of Traffic Capacity of Roads (Main Routes).

ANNEX F

STATISTICS OF LOSSES AND REPAIR RATES

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Table 114.* Manpower Casualties of Tank Armies in Offensive Operations.

	Operation	Army	Casualties in Manpower		Remarks
			Overall % in relation to strength at start of operation	Killed and Missing % from overall	
1	Orel	2TA	11.2	31.8	
		4TA	21.1	28.2	
2	Belgorod-Kharkov	1TA	24.9	24.1	
3	Proskurov-Chernovits	1TA	22.9	20.9	
4	Lvov-Sandomir	3GTA	14.5	26.3	
		4TA	10.8	25.9	
5	Lyublin-Brest	2TA	10.2	24.9	
6	Visla-Oder	1GTA	14.5	27.0	
		2GTA	7.2	31.5	
		3GTA	8.7	24.0	
7	East Prussian	5GTA	17.5	24.0	
8	East Pomeranian	1GTA	12.4	23.0	
		2GTA	14.5	16.0	
9	Berlin	2GTA	12.4	20.0	
		3GTA	14.7	21.0	

* Tankoviy Udar, A. I. Radziyevskiy, Table 32, p.241.

*

Table 115. Correlation of Reparable and Irreparable Casualties of Tanks and SP Guns in Tank Armies in Several Operations of the Great Patriotic War.

	Army	Operation	Period under Consideration in days	Casualties Liable for Repair		Remarks
				Casualties Due to Battle Damage in %	Casualties due to Tech Reasons and Bogging Down in %	
1	1GTA	Belgorod-Kharkov	29	55.5	44.5	
		Lvov-Sandomir	12	79.2	20.8	
		East Pomeranian	8	60.0	40.0	
2	2GTA	Orel	9	70.3	29.7	
		Visla-Oder	16	70.6	29.4	
3	3GTA	Visla-Oder	19	75.7	24.3	
4	4GTA	Orel	10	94.3	5.7	
		Visla-Oder	13	78.0	22.0	
5	5GTA	East Prussian	25	46.4	53.6	
On average			16	46.4	53.6	

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* Tankoviy Udar, A. I. Radziyevskiy, Appendix 5, p.266.

Table 116.* Percentage of General and Daily Average Casualties of Tanks and SP Guns of Tank Armies in Several Operations of the Great Patriotic War.

Ser No.	Army	Operation	Period in which casualties were suffered (days)	General losses repair the operation	Beyond economical repair casualties	Daily Average Casualties		Remarks
						General %	Beyond Economical Repair	
1	1GTA	Belgorod-Kharkov	29	185.0	51.4	6.4	1.8	
		Lvov-Sandomir	12	102.4	28.8	8.5	2.4	
		East Pomeranian	8	24.6	8.4	3.1	1.0	
2	2GTA	Orel	9	111.8	21.0	12.4	2.4	
		Visla-Oder	16	36.0	10.0	2.3	0.6	1 Belo-Russian Front
3	3GTA	Visla-Oder	19	56.4	19.8	3.0	1.1	1 Ukrainian Front
4	4GTA	Orel	10	75.0	34.3	7.4	3.4	
		Visla-Oder	13	56.4	15.7	4.3	1.2	1 Ukrainian Front
5	5GTA	East Prussian	25	72.0	35.9	2.9	1.4	
On average			16	82	25	5.3	1.7	

Note. In the breakdown of overall daily average loss rates of 5.3%, up to 0.6% required base workshop repair, this together with casualties beyond economical repair consisted of 2.3%, the remaining 3% requiring unit and 2nd Line Repair (light and medium repair).

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* Tankoviy Udar, A. I. Radziyevskiy, Appendix 4, p.265.

Table 117.* Distribution of Battle Losses of Tanks and SP Guns in Tank Armies Offensive Operations According to Weapon Systems.

Operations	Army	Casualties/Losses %				Other Reasons
		Results of Arty Fire	From Mines	From Aviation	From Panzer-Faust RL	
Orel	2TA	76	14	10	-	-
	4TA	68.5	8	17.7	-	5.8
Kiev	3GTA	94.8	2	0.5	-	2.7
Lvov-Sandomir	3GTA	80	6	14	-	-
	4TA	91.8	3	3.4	-	1.8
Visla-Oder	3GTA**	88.5	2	9.5	-	-
	1GTA**	63.1	5.3	10.5	20	1.1
	2GTA**	79.5	2	1.5	-	17
	4TA**	78.5	9.5	1	6.2	4.8
Berlin	2GTA***	58.7	5.8	6.6	24	4.9
	3GTA****	67.1	6.6	10.3	16	-

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* Tankoviy Udar, A. I. Radziyevskiy, Table 23, p.220.

** Armies employed as mobile groups in Visla-Oder Operation.

*** 2GTA together with 1GTA mobile groups in 1 Belorussian Front.

**** 3GTA with 4GTA mobile groups in 1 Ukraine Front.

Table 118.*&** Rate of Advance of Tank Armies of 1st Belorussian Front and Redeployment Sequence of Evacuation and Repair Facilities of 1 Guards Tank Army in Visla-Oder Operation.

Date	Tank Armies Rate of Adv Km	Duration and Location of SPAMs 136 136 67 67	Overall No of AFVs Requiring Repair	Disposal of Casualties			Deploy Ser No.
				Rep'd	Insp and Repair	Backloaded to Front Workshops	
Jan 45							
15	11						
16	30-70						
17	15-55						
18	35-45	----------	23	8		15	1
		----	38	30		8	2
19	45-70						
20	20-45	----------	61	19	32	10	3
21	45-50						
22	40-60	--------	104	39	51	14	4
23	10-45						
24	0-50						
25	20-40						
26	12-30						
27	5-10						
28	25						
29	15-25	----------	123	23	90	10	5
		----------	30	15	15-		6
30	30						
31	25-40						
Feb							
1	0-40						
2	20						7
3	---	----	115	33	75	7	8
4		----------	91	21	65	5	9
11		----	71	24	28	10	10
12							
13		----------	15	15			

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* VIZH No 1/65, p.77.

** VIZH No 4/67, p.19.

Date	Tank Armies Rate of Adv Km	Duration and Location of SPAMs 136 136 67 67	Overall No of AFVs Requiring Repair	Disposal of Casualties			Deploy Ser No.
				Rep'd	Insp and Repair	Backloaded to Front Workshops	
On the periphery			67	67			
20/23 Days	560-700km		738	294	356	88	

Key

SPAM 136

1.	Nove Miyasto	18-20 Jan
3.	Striykuv	20-29 Jan
5.	Piotkruv	29 Jan-7 Feb
6.	Veiskauliyand	29 Jan-4 Feb
8.	Krisht	4-13 Feb
10.	Zoldin	13-18 Feb

SPAM 67

2.	Nove Miyasto	18-22 Jan
4.	Kolo with det at Konin	22 Jan-3 Feb
7.	9km SW of Al'ttirshtigel	3-11 Feb
9.	Shtol'genberg	11-26 Feb

Table 119.* State of Fighting Vehicles - 1 and 2 GTA on 1 Feb 45.

Formation	Number of tanks and SP Guns on establishment	Broken Down Into				Beyond economical Repair (BER)	Remarks
		Serviceable	Required Repair				
			Light	Medium	Heavy		
1GTA	758	577	26	60	27	68	
2GTA	856	495	107	146	33	75	

Table 120.** Influence of Tempo of Advance on the Volume of Repair Work to be Done on Tanks. Experience of 1GTA.

Speed of Advance km in 24hrs	Percentage of Repaired Vehicles									Remarks
	Light			Medium			Heavy			
	Army OTRB	Corps PTRB	RTO Units	Army OTRB	Corps PTRB	RTO Units	Army OTRB	Corps PTRB	RTO Units	
5-10	6	15	79	43	32	25	20	21	59	
15-20	20	27	53	49	42	9	35	30	35	
40-50	50	-	50	95	-	5	70	-	50	

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* VIZH No 4/67, Table 2, p.21.

** Ibid, Table 3, p.21.

Key

OTRB - independent tank repair battalion.

PTRB - AFV repair workshop.

RTO - unit tank repair detachments.

ANNEX G

REAR SERVICES COMMAND 1986.

Post	Name/Rank	Date Appointed/ Identified
Deputy Minister of Defence - Chief of Rear Services	Marshal of the Soviet Union S K Kurkotkin	1972
- First Deputy Chief	Colonel General P I Sysoyev	1970
- First Deputy Chief - Chief of Staff	Colonel General I M Golushko	1970
- Deputy Chief of Rear Services	Colonel General N S Rozhkov	1976
- Deputy Chief of Rear Services	Colonel General G T Tarasov	1979
- Head, Political Department - Staff and Directorates	Lieutenant General V P Timonin	1982
- Chief, Personnel Directorate	Lieutenant General V G Zaytsev	1970
- Chief, Central Finance Directorate	Colonel General V N Dutov	1957
- Chief, Central Military Medical Directorate	Colonel General of Medical Services F I Komarov	1976
- Chief, Military Veterinary Services	Major General of Medical Services O S Belen'ky	1979
- Chief, Central Clothing Directorate	Lieutenant General F P Petrov	1969
- Chief, Central Food Supply Directorate	Colonel General I D Isayenko	1965

Post	Name/Rank	Date Appointed/ Identified
- Chief, Central Military Communications Directorate	Colonel General A S Klemin	1976
- Chief, Central Auto-Tractor Directorate	Lieutenant General I V Balabay	1978
- Chief, Main Fuel Supply Directorate	Lieutenant General I N Bazanov	1983
- Chief, Main Railway Troops Directorate	Colonel General M K Makartsev	1983
- Chief, Roads Directorate	Lieutenant General N Vasil'yev	1984
- Chief, Main Trade Directorate	Major General N G Sadovnikov	1986
- Chief, Tourist Directorate	Major General A P Gashchuk	1981
- Head, Rear Services and Transport Academy	Colonel General K N Abramov (now 74)	1966

ANNEX H

SOVIET ENGINEERING EQUIPMENT AND NORMS.

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Appendix 1 to Annex H

BRIDGING AND WATER CROSSING EQUIPMENT.

The PMP is the Soviet division's main item of bridging equipment. A division has a half set to 16 river and 2 bank sections, plus 6 towing launches. 72 men in the company can lay a 20m bridge in 20 minutes. Each pontoon link is transported folded on a flat lorry, which backs to the edge of the bank and drops the pontoon into the water. Each pontoon unfolds instantly and is secured to other pontoon links by quick fastening top and bottom bolts. A bridge can be constructed along a river bank, launching all pontoon links simultaneously, attaching them, and swinging the bridge into the river; or as each pontoon link is assembled across the river, a lorry can back onto it to launch the next pontoon.

PMP Characteristics

River Links	Bank Links	Towing Launches (BMK-T) (BMK-150)	Vehicle Type
32	4	12	KraZ-24

Capacity	Width of Passage	Length (m)			Time
		Total	Floating	Laying	Recovery
60t	6.5	227	226	30	60
20t	3.29	382	371	50	100

PMP Ferry Characteristics - N.B. 60 tons max.wt. for any individual vehicle.

Capacity ref speed of current		Dimensions		No. of Ferries	Construction Time
Upto 2m/sec	Over 2m/sec	length	passage width		
40	40	13.5	6.5	16	8-10
60	60	20.25	"	10	10-12
80	80	27	"	8	12-15
110	110	39.25	"	6	15-18
120	120	40.5	"	6	15-18
120	150	54	"	4	20-25 (higher times for faster currents)

PMP speeds of traffic 20-25kph day, 15kph night
wheeled vehicles can cross PMP side by side if necessary
Ml-6 (Hook) helicopter can lift river and bank links underslung.
PMP can be coupled with TMM.

A 20 tonne capacity bridge can be made by disassembling every second pontoon section into 2-1/2 sections, and reassembling the bridge so that one complete section alternates with two half sections, thus "stretching" a 120m bridge to almost 180m. End links cannot be split.

MTU Bridge Characteristics

	Chassis	Obstacle span	Class	Deployment time
MTU-54	T-54	single 11m	50	5m
MTU-20	T-55	folded ramp 18m	50	7m
MTU-55	T-55	double scissor 15m	50	7m

Heavy Mechanised Bridge TMM

Details	Weight Tonnes	Vehicle	Class	Assembly Time (min)	Road Max	Speed Aver	Veh Range	Crew	Obstacle	
									span	depth
1 bridge section	19	KRAZ 214	60	8-15	55	25-30	650k	3	9.5m	3m
set of 4 sections	-	-	60	30-60	-	-	650k	12	40m	3m

Recovery time - 45-70 minutes per section.

TMM can be laid under water: this takes 50% longer to erect. It can also be coupled to PMP.

See illustration and photo for deployment.

PVD-20 - Pontoon bridge for airborne forces - light and small sections for air or helicopter transport, can be paradropped.

The pontoons are inflatable boats NDL-20 (weight 115kg) with Duraliumin spans (weight 100kg) spaced at different intervals to suit different traffice requirements.

A bridge set will also make up to 104 ton capacity ferries. The weight of each such ferry is 1,200kg, and it can be loaded onto a GAZ-66 vehicle.

Details of ferries and bridges made from a PVD-20 set

		Bridges	Ferries	
Capacity	Max. Length	Laying time (minutes)	No. made from 1 set	Assembly Time (min)
4t	88.2	50	10	15
6t	88.2	50	6	20
8t	64.6	50	4	25

Towing Launches are used to aid the construction and positioning of pontoon bridges. They can also be used for firefighting and decontamination.

The standard launch is the BMK-T carried on a KRAZ-214

Maximum towing capacities) forward 2,000kg
) rearwards 900kg

Speeds empty 20kph

Towing 60 tons PMP 9kph

The BMK-T can operate in upto force 5 wind and force 3 'sea', i.e. it can stand upto 1m high waves. The boat is constructed in 4 non-sinking sections, and can float with only two sections intact.

Assault Crossing Vehicles

	Payload (tons)		Speed (kph)		Range		Loaded max. exit gradient
	on land	afloat	on land	afloat	on land	afloat	
MAV							
BAV	2.5	2.5					12-15o
K-61	3.5	5	35	8-9	170k	8 hrs	20o
PTS	8.5	11.5	39	8-9			25o
PKP trailer	4	5.5	-	-			
GSP	-	50	30	7-8			

Although the PTS is the standard amphibious assault crossing vehicle now in production, a large number of K-6's are still in use, and even the old MAV's and BAV's copies of DUKW's given on land-lease are still in widespread use, MAV's with recce engineer sub-units are BAV's with rear service troops.

The amphibians are primarily designed for the transport of artillery and artillery tractors. They can carry any gun and most tractors.

The GSP is designed for carrying tanks, SP guns and other tank based equipment.

Bridge Construction Equipment

The KMS bridging set is for construction of semi-permanent low and underwater bridges, mainly in rear areas, on LOC's etc., using locally available material: it is prepared on site when pre-prepared components are not available.

The KMS complex includes:

Pontoon mounted piledriver for span erection with auxiliary launch DL10 for erection of elements of a piled pier DM-150 rod operated diesel motor with the OSK single shot piledriver, the DB-45 pileless rod operated diesel hammer; the S402 electro-vibrating hammer. The diesel hammer and electro-vibrating hammer are designed for seating wooden piles 25cm diameter upto 4m and 7m depth respectively at roughly 20-70cm per minute in firm clay. The KMS complex can be carried on 5 ZIL-157 vehicles and requires 28 men. The hammers need extra operators. Using prepared wooden or ready-made components a trestle pier bridge can be constructed at a rate of 20-25m per hour and a pile pier bridge at 15-20m per hour.

Diving Gear

Type	Kit weight	Weight as worn	Maximum operable depth	Endurance
Light diving apparatus LVA & IDA (oxygen)	20kg	16kg	20m	3-6 hours
Breathing apparatus for underwater or general use, e.g. firefighting	14.5kg	11kg	20m	1-2 hours
Full diving rig SVV-55	240kg	106kg	20m	Hose supplied
AT-1 breathing apparatus	8.8kg	8.8kg	40m	at 40m-15 mins at 10m-1 hour

Inflatable Assault Boats

Type	Weight Kg	Inflation time (mins)	Crew (with motor, only 2 in all cases	Load		Max. speed M/Min	
				men	Payload (tonnes)	outboard motor	paddle
NL-5	50	5	2	5	0.5	-	50-60
NL-8	55	4	2	8	0.65	130	50-60
NDL-10	80	5	5	5	1.2	130	50-60
NDL-20	150	5	7	27	2.5	130	50-60
NL-30	200	6	7	30	3.4	120	75
*DL-10	420	3-4	5	25	3	200	85

Soviet engineer officers, during their four years training at one of the Military Engineering Colleges, spend a great deal of time studying NATO engineering techniques, particularly of US and German forces. They especially study defensive engineering works, minefields, etc., and an example of their teaching on NATO minefields is given in Fig.4. Defence of built-up areas, the style and organisation of NATO mobile, linear and strongpoint defensive tactics are all studied in great detail, and, in general, presented as being extremely effective. The cynical western reader could draw the conclusion that Soviet engineer officers' constant harping on the ability of NATO defences to hamper a high speed attack is merely an attempt to get a bigger slice of the military budget for more Soviet engineer assault equipment. There is more than a grain of truth in this conclusion but it must not be allowed to obscure the fact that, if NATO can deploy and prepare its defences well, the Soviets will be very hard pushed indeed to maintain the tempo of their offensive, and their fears of it grinding to a halt in the manner of the Arab armies on the Golan Heights in 1973 are not so wildly unreasonable as they may have at first sight seemed. It would be far more realistic to draw from the study of Soviet teaching on NATO defensive tactics the conclusion that the Soviet Army, including their combat engineers, would find it far more profitable,

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* N.B. DL-10 is made of treated plywood, and breaks into two sections for transportation.

if they had to go to war, to launch an offensive achieving such surprise that NATO forces had no time to dig in. The attainment of such surprise would be well worth accepting slightly less than perfect preparation at the start. There is no doubt that the engineers concentration on their ability to maintain march routes is an important reflection of this desire to fight such a fast war.

Appendix 2 to Annex H

CALCULATIONS AND NORMS FOR PLANNING ENGINEER TASKS.

Engineer norms are almost as important as constituents of calculations for sustainability as are artillery norms. These examples of Soviet manpower and equipment requirement norms for engineering tasks calculate times for soft ground. For hard ground times should be doubled, for frozen or stony ground - quadrupled. One man/day equals 10 hours, but it should be borne in mind that many tasks require skilled labour, and allocation of engineer resources is more than simple arithmetic, often presenting quite a problem for the commander.

Task	Time requirements	Excavated Volume (cu.m.)
Firing Trenches		
Individual foxhole for firing standing up	2 man hours - with spade	1.4
Sectional slit trench 50-60m	10.5 man days	50-60
Deep communication trench or similar per 10 running metres	1.2 man days or 2 mins with a BTM	11
Dug out firing position for D-30	5-6 man days plus 1.3 hours with BAT	90
Firing scrape for BM-21	3 man days plus 3 hours with BAT	75
Firing trench for T-62 deep, with limited field of fire	1.1 man days plus 1.4 hours with tank dozer	42
Firing trench for SP-122 with limited field of fire	1.5-2 man days using explosive charges	38
Simple firing trench for BTR-60 using only turret gun	2 man days plus 1.1 hours with tank dozer	60
OP's and CP's		
Shallow open trench for sub-unit cdr COP	0.6 man days	5
Artillery Battery Cdr COP	2.5 man days	20
Artillery Battalion Cdr COP	3.7 man days	30
Covered observation posts reinforced with corrugated steel and periscope facilities	10.5 man days	30

Task	Time requirements	Excavated Volume (cu.m.)
Pit for SSV e.g Gaz-66 or AT-L	7 man days. 3.2 bulldozer hours 2.6 excavator-crane hours or entirely by hand - 20 man days	130 (including 70 by hand)
	(a) on flat ground for 2 vehs: 1.5 man days and 1.1 bulldozer hours	55
	(b) on a reverse slope for 1 veh: 1.8 man days	15
Pit for 80 cans of pol lightly covered	1.2 man days plus 15 mins with excavator	17
Obstacle Clearing. Example of	manpower and equipment norms.	

Task	Requirement	Width of Path
Clearing own mines from in front of defence before an attack		
(a) By hand	Sapper sect with minedetectors	6-8m upto 50m per hour
(b) With explosive devices using a line projector and winch	Sapper sect with U2-3 bangalore torpedoes and a winch	6-8m upto 100m per hour
Clearing enemy mines during an attack		

Task	Time requirements	Excavated Volume (cu.m.)
(a) With a tank equipped with mine ploughs	-tank with KMT 4/5/6	Track path only at 6kph
(b) With a tank and explosive devices	-tank with KMT and sapper sect +20-30 bangalore torpedoes of the U2-3 type	5.5m 300-500m per hour

Demolition

Task	Requirement	Time
To destroy 1 running metre of the span of a metal girder bridge	5kg high explosive	1-1.5 man hrs
To destroy the span and one pillar of a reinforced concrete girder bridge	670kg HE	2-8 man days
To destroy 10m of the span of a stone arch bridge with charges laid on the arch key	140kg HE	1-5 man days
To breach a stone or brick wall per 1M3 of masonry breached		
(a) external charges	5kg HE	30 mins
(b) charges placed in prepared niche	2kg HE	45 mins

Task	Requirement	Time
To demolish brick or stone building with internally laid charges with 1M3 of volume of ground storey or basement	upto 1kg HE	5-10 mins
To disable:		
a tank with a concentrated charge placed externally at the turret race	1.2kg HE	2 mins
a vehicle, APC; with a charge on the engine block	4-0.8kg HE	2 mins
a gun or mortar; with a charge placed in the bore, when the calibre = Xmm	approx. 1kg x $\frac{Xmm}{50}$ e.g. 122mm gun approx 2.5kg	1-2 mins

Road Opening and Gap Crossing

Task	Requirement	Time
Filling in a simple ditch or trench	Grader, BAT or BTU	2 mins
Filling in an anti-tank ditch	Grader, BAT Bulldozer	10 mins 20 mins
Filling in a 10 M3 obstacle	BAT	2-4 mins
Assembling a trackway bridge with pulleys of:		
12 ton capacity	2 sapper sections	10-12 mins
40-60 ton capacity	motorized crane and 1 sapper section	8-10 mins
Assembling one section of: a vehicle	KMM	6-8 mins
Mounted truss bridge	TMM	8-10 mins
Laying 100 running metres of flexible trackway covering:		
(1) on soft ground	1 sapper section and vehicle	5-10 mins
(2) on swamp	1 sapper section by hand	60 mins
Clearing a 4-5m land through 100m tree obstacle	sapper pl BAT, or IMR, explosives	1-1.5 hours
do., but through nuclear tree blow down	do.	30-60 mins
do., but through mined tree obstacle	do., plus minedetectors	2 hours

Task	Requirement	Time
Clearing a 3-4m lane through a medium density wood - per 1km.	sapper pl BAT or BTU	20-30 mins
Clearing 3m wide lane 1km through .5m deep snow	Bulldozer	20 mins
Clearing 4m wide lane 1km through .5m deep snow	BAT	8-10 mins

Crossing Freshwater Ice and necessary ice depths without strengthening.

Vehicle all up wt	Thickness of ice and ambient temperatures			Vehicle Spacing
	-10oC & lower	-5oC-0oC	above 0oC	
(a) Wheeled				
2 t eq UAZ 469	16cm	18cm	20cm	15m
10 t eq ZIL 131	35cm	39cm	44cm	25m
15 t eq URAL 375/7 BTR 60	48cm	52cm	57cm	30m
(b) Tracked				
16 t eq BMP, 50 23-4	36cm	40cm	45cm	25m
40 t eq T-62	57cm	63cm	71cm	40m

Laying Strip Minefields

Type of Mine	No. per KM	Time for laying per mine	
		(a) at night on forward positions	(b) in depths of defence
TM-46 TMD-B	750	.2 man hrs	.166 man hrs
PMD-6	2,000	.16 man hrs	.066 man hrs
POM2-2	300	.25 man hrs	.2 man hrs

Camouflage measures

Task	Requirements		Material
	Man days	Machine hrs	
To camouflage: 1km of trenches	15		10M brushwood
To erect: 1km of roadside camouflage from visual and radar and IR observation, constructing a pole and wire carcase with a cover of:			
(a) brushwood and fresh branches and netting	53		500m poles & 100M brushwood
(b) straw matting and camouflage netting	200		150m poles
(c) 4-5mm metal link netting	35		300m poles
To dig: 1km false trench	10	.7 with PLT vehicles	
1km false fire trench		.15 with a bulldozer	
1km false anti-tank ditch	2	5 with a bulldozer	
To make: 1km false roadway in winter		1hr with a grader 2hrs with bulldozer .25hr with snowplough	

Calculated daily water supply requirements:

(1) Personnel: litres per man

Conditions	Climate	on march or in attack	in defence or static
In areas with a plentiful supply:	(a) temperate	8	10
	(b) hot	10	15
In areas with a sparse supply:	(a) temperate	8	8
	(b) hot	10	10
In exceptionally difficult conditions (absolute minimum)	(a) temperate	2.5	2.5
	(b) hot	4	4

Cannot be maintained for more than 5 days (3 days in hot climate). In areas with plentiful supply of salt water, fresh water as above supplies are halved.

(2) Vehicles

Type of vehicle	Quantity in litres		
	engine coolant fill	engine top-up	wash down
Tank SP Gun	70-90	8-14	150-200
UAZ 469	13	1)	50-100
GAZ 66	15	1.2)	
URAL 375	40(est)	2.5-3.5)	
BRDM	15	1.2)	100-200
PT-76 ZSU 23/4	45	3)	

(3) Water requirements for NBC decontamination.

Type of vehicle or equipment	with TMS-65	ADM 48 or ARS 12
Tanks SP guns, Hytracked movers etc	1000	100
Wheeled APC's	800	100
Lorries	600	75
Field guns 100mm cal. & above	450	55
Mortars and light guns/AA MG's	250	40
Light weapons		1 litre

Machines for Cutting and Preparing Wood

A great many Soviet engineer tasks rely on a plentiful supply of logs for their completion - dug-outs and shelters, corduroy roads, certain bridges (KMS) etc. Consequently the Soviet Army is well supplied with the wherewithal to cut and prepare and split logs, and to saw lumber into beams and planks.

Details of self-contained wood cutting equipment (see also generators)

Type	Weight (kg)	Productivity in a 10 hour shift				Crew	Setting up time (minutes)
		Felling trees	Cutting bushes	Sawing			
				planks M3	beams M3		
Hand saw	11.5	200	250	-	-	1	5
TsDT 4 Circular stripping saw	1800	-	-	24	42	7	90-120
Portable frame saws							
RP 75	5500	-	-	40	50	8	180-240
LRV	6600	-	-	50	70	8	90-120

Portable frame saws are mounted on a trailer.

Generators are provided for lighting CP's and certain working areas (e.g. hospitals) as well as for supplying electricity for instruments and equipment. Brief details of trailer mounted military generators.

Type	Total Weight	Current	Voltage	Power (kw)	Crew	Set up time (mins)
Petrol driven lighting generators						
ESB1-VO	400kg	AC single phase	230	1	2	40
ESB2-VO	900kg	AC single phase	230	2	3	60
Petrol driven engineer generators	tonnes					
(a) Ground working*						
ESB-5-IG	2.6	AC	230	2-4	3	30
(b) Tree preparing						
ESB-4-IL	1.7	AC	230	4	3	30
(c) Wood cutting						
ESB-4-ID	1.8	AC	230	4	3	30
Power Generators (diesel)						
ESD-10-VS	2	AC triple phase	230 or 400	10	2	60-120
ESD-50-VS	6.2	AC triple phase	230 or 400	50	2	60-120
ESD-75-VS	8.2	AC triple phase	230 or 400	75	2	60-120

*

Notes on petrol driven Engineer Generators - The ground working generator set includes 3 electric hammers, 2 electric perforators, 2 mounted electric drills, and a grindstone. The tree preparing set includes 6 electric chain saws, and electric winch and a grindstone. The woodcutting set includes 4 electric chain saws, an electric plane, an electric winch, 2 hand held electric drills, a circular saw and a grindstone.

Water Supply and Purification Equipment

Boring rigs; rod operated plunger pumps; motor pumps; bucket lifts; filter stations; desalination equipment designed to purify; decontaminate and desalinate water.

At natural springs and open water supplies the following are widely used: MAFS-2 vehicle filter station OPS and POU-4 desalination systems mounted on ZIL-157. Vehicle filter stations cleanse water not contaminated by radioactive particles at a rate of 8M3 per hour; and radioactive water, at 4M3/hour. The stations take 80 minutes to set up.

The POU desalination machines produce 300 litres per hour and the OPS 1800 litres per hour maximum. They take 1.5-2 hours to set up.

Water Bowsers and Cisterns

Type	Weight (kg)	Capacity(L)	Crew	Time taken to set up (mins)
Vehicle Bowser ATVs-28	9370	2800	1	16-20
Storage tank RTs-1200	35	1200	1-2	5
Containers				
RE 6000	60	6000	1-3	10-30
BTR 100	5	100	1	2
Knapsack water container	1.2	12.5	1	10

Prefabricated Kits for Shelter Installations

Type	Contents of Kit	Internal Dimensions	Weight (+)
KVS-U corrugated steel kit for the light shelter	23 corrugated steel sheets 2 face diaphragms, partitions with airtight doors, covered air locks, protective airtight entrance hatch, ladder spare instruments and fittings.	4.25m long	1.3
KFU-2 Sectional plywood installation	5 circular ring sections, (-3 frame, one vestible and one front access sections) 3 end panels, an airtight partition, 2 entry shields an entry hatch and a ladder.	4.4m long 1.8m dia.	1.4
Light Cloth frame installation LKS	Duralumin skeleton canvas panels, an end panel an airtight screen with protective door and entrance equipment.	5.5m long 1.9m high 1.5m wide	0.33
LAZ Protective airtight shelter entrance	Shield panel, hatch and ladder.	Diameter of entry port 70cm length of panel 1.55m	0.08

Type	Construction requirements	Numbers carried on ZIL-157
KVS-U corrugated steel kit for the light shelter	4 man days and 2.5 machine hrs with bulldozer	2 complete kits. A section can load 2 in 30-40 mins & unload in 20-30 mins.
KFU-2 Sectional plywood installation	6 man days 2.7 hours with a bulldozer	as for KVS-U
Light Cloth frame installation LKS	5 man days	6 complete kits can be loaded by a section in 30 mins.
LAZ Protective airtight shelter entrance	1.5 man hrs plus time taken to prepare shelter room etc	30 kits on a ZIL-157 1 kit on a BTR 50 or 60 with a full crew.

Appendix 3 to Annex H

DETAILS OF SMOKE GENERATORS.

Details of Smoke Generators Issued at Unit and Divisional Level. Larger Generators are Available at Army Level.

	DM-11	DSKh-15	8DSh-5	BDSh-15
Dimensions (cm)				
Height	11.5	34.5	48	48
Diameter	16	16	41.2	41.2
Weight (kg)	2.3-2.7	7-7.5	45-50	45-50
Burning time (mins)	5-7	15	5-7	15
Duration of effective smoke cloud in average meterological conditions (mins)	50-70	50-70	200	115
Width of smoke cloud at the end of the smoke curtain (metres)	15	15	40	30
Number of pots that can be carried on a ZIL-131	1200	600	80	80

Artillery and mortar smoke shells burn within 1-3 seconds and their white smoke cloud, depending on calibre, lasts only from 10-30 seconds. They are useful for delivering a surprise smokescreen into an enemy position, but an effective screen requires very large quantities of shells and close co-ordination of artillery fire due to the vulnerability to DF of any one battery or battalion firing continuously for more than 10 minutes.

Heavy smoke generation equipment is operated by the chemical troops.

Appendix 4 to Annex H

DETAILS OF STRAP-ON ENGINEER EQUIPMENT.

The following strap-on engineering equipment for tracked vehicles is available.

Dozer/Plough Blades

TK Bulldozer BTU

TK Snowplough STU-2M

OT-T to AT-T

OS-T to AS-T

OL-T to AL-T

Bulldozer blades attach to same lugs on a tank as do mineploughs. Such blades can cut from 2.5cm to 20cm deep at a time. Their particular advantage is the good crew protection, and the independence that they give a tank unit in engineer working capability.

These equipments are used for:

Road maintenance, but can also be used for excavating weapon pits and vehicle dug-outs. They are very useful for preparing bridge approaches, gap filling, trench filling, rubble clearing, road cutting on slopes, rooting out stumps, snow clearing, etc.

Graders can alter angle of doze, bulldozer can not, BAT-M has a crane for general constructional tasks, and is mounted on AT-T body. The wheeled grader PKT and wheeled bulldozer BKT are not so strong as BAT, but have higher road speeds; the PKT has more manoeuvrable blade.

Appendix 5 to Annex H

ENGINEER ORDNANCE.

Mines

Details of the most advanced type of Soviet mines are not available; however the Soviets will undoubtedly use a very large number of conventional mines of the simplest type as, in view of their mine warfare doctrine, these are quite adequate for most needs.

The most important features of a mine, in the Soviet view, is speed and ease of laying on the battlefield. A belt of pressure mines is hundreds of times more effective an obstacle to infantry and tanks than trenches, wire, or other fortification in terms of the man hours needed to create the obstacles. Mines, in other words, are a much quicker means of erecting a defence, and are in consequence widely used even in offensive operations.

Mines are easily transported on the battlefield and some mine obstacle can be manoeuvred in a way an anti-tank ditch can not. In any future war, the Soviets believe, there will be no distinct front line or even a straight and stable 'Forward Edge of Battle Area'. Instead there will be a series of offensive and counter-offensive axes "spurs and re-entrants". Laying minefields will be the most common means of erecting flank defences, particularly as an obstacle to tanks and APC's. The areas sown are expected to be many times greater than those laid to mines during last war operations. Mines, in other words, are, for the Russians, more important weapons nowadays than ever before. The advent of the remotely delivered mines (varieties of which have been successfully used in Afghanistan by the Russians) have brought a new dimension to the art of rapid mining, permitting mines to be laid behind enemy lines.

The Soviets recognise four categories of mine: anti-tank; anti-personnel; anti-assault and special mines. Soviet anti-tank mines are primarily anti-track; some types of current use are TM-57, TM-46, TMD-B and TMD-44. Anti-personnel mines are of the blast type (PMD-6M PMN) and fragmentation type (POMZ-Z, OZM-3, OZM-4). Anti-assault mines for shore and river use are bottom laid (PDM-1M, PDM-2) or anchored (YARM). 'Special' mines include delayed action weapons MZD-5M, MZD-60, mines for laying under ice (APM) and signal mines, flares, etc.

Details of Soviet Mines

Type	Weights (kg) Mine	HE content	Body Material	Fuse Type	Pressure require-ment (kg)	Diameter Size (cm)
Anti-Tank						
TM-46	8.6	5.7	metal	MV-5 MUSH-46	500-700	30
TMD-B	9.7	6.7	wood/ plastic	MV-5 MD-2	250-500	32x29x16
TMD-44	9.8	6.7	wood/ plastic	MV-5 MD-2	250-500	32x29x16
Anti-Pers						
PMD-6 (HE)	0.5	0.2	wood/ plastic	MUV MD-2	6-28 1-12	190x90x50
POMZ (fragment)	2.3	0.075	metal	MUV MD-5 MD-2	0.5-1.3	6

Type	Laying interval (metres)	Notes
Anti-Tank		
TM-46	4	anti-track
TMD-B	4	anti-track
TMD-44	4	anti-track
Anti-Pers		
PMD-6 (HE)	1	effective only on a target in direct contact
POMZ (fragment)	6	effective radius 4m

Details of scatterable mines (time and movement/contact sensitive) have emerged from Afghanistan during the past years. However the Soviet press does not yet carry details of these weapons. They will supplement, not replace, existing minelaying practices.

Special charges are issued to engineer units on a wide scale for demolition, cratering and digging, destroying abandoned equipment, and clearing paths through obstacles and fortifications. There are three types of special charge on general issue, concentrated charges (SZ); shaped charges (KZ) and bangalore torpedoes (UZ).

HE substances, detonators and explosive cord are issued for demolition work and for supplementing mine charges. HE types in common use are hexagon, TNT, tetryl and ammonite. Detonating explosives are stabilised fulminate of mercury, lead azide and lead syphnate. The most

common engineer charges are of TNT in powered, pressed or slab form.

Details of Concentrated Charges and Shaped Charges

Type	Weight (kg)		Size cm	Armour cm	Effective penetration cm	
	Total	HE content			Ferro-concrete	Brick & Stone
Concentrated						
SZ-1	1.4	1	6.5x11.6x12.6	1.3	25	40
SZ-2	3.7	3	9.8x14.2x20	2.0	35	60
Shaped						
KZ-2	14.2	9	35 dia. 24 h.	30	130	200
KZ-U	18	12	50x22.5x19.5 (stand on legs 57 high)	12	100	150

Minedetectors

Type	Weight (kg)	Maximum area searched M2/hr Operator		Strip width search (cm)	Maximum detection depth for Soviet mines (cm)				
		standing up	lying down		TM-41	TMD 44	TMD B	POM-with MUV	FAB 50
Minedetector									
VIM-625-B2	8	350	-	30	35	8	-	-	-
UMIV-1	7	200	100	25	35	15	-	4	-
UMIN	7	250	100	30	40	12	12	8	-
Ferromagnetic body detector (bomb detector) LFT 6 man crew	190	on land 400 to 600 under water 250	-	-	-	-	-	-	220

Type	Depth of water search (m)	Effective operating duration (hrs)	Operating range degrees Cent.
Minedetector			
VIM-625-B2	1.2	Filament 70 Anode 100	-40 - +50
UMIV-1	will not work under water	Filament 2 Amode 100	-30 - +50
UMIN	1.2	80	-30 - +40
Ferromagnetic body detector (bomb detector) LFT 6 man crew	15	60	-

Bangalore Torpedoes (Hose charges)

Type	Construction	Weigh per running m		Effective width of action	Max Reliable length layable		
		HE	Total	metres	By winch	projected from tank or APC by Rocket	Towed by Tank
UZ-1	O Single	2.65	5.1	2.5-3	300	-	-
UZ-2	OO paired	5.3	11	4-5	300	200	3000
	OO paired on trolley base	5.3	13	7-8	500	-	5000
UZ-3	O Triple OO superimposed	8	16	8-10	300	200	3000
	O - ditto - OO on trolley base	8	18	10-12	500	-	5000

Engineer Reconnaissance Equipment.

In the Soviet concept, this includes devices for observation and photography; devices for mine and shell detection; equipment to conduct recce of water obstacles and all the various means of measuring the "going"; - type of ground, thickness of ice, gradients, swamp conditions, current speeds, depth, width and bed conditions of rivers.

Appendix 6 to Annex H

OTHER ENGINEER EQUIPMENT.

Details of selected Soviet recce equipments - (a) optical periscopes

Type	Weight kg	Periscopic height (cm)	Field of vision o	Magnification X	Range (km)
Engineer recce					
P.I.R	3	450	8	15	3-4
P.I.R-20	1.3	450	2.5	20	3-4
Large magnification periscope PBU	10	535	1-1.5	20 + 40	4-5
Field fortification periscope PFP-5	22.5	2530	7	5	5-6
Periscopic long-focus camera PDF	22	520	6.5	6 + 30	7
Engineer range finder DSP-30	3.4	300	-	12	50 to 2000M abburate to 0.4% per 100m

Photographs taken by the PDF apparatus can be developed in the mobile engineer photo lab PIF, mounted on a ZIL 157. This lab can produce 40-60 13x18cm prints per hour. The PDF uses a 1.6m film strip of 36 exposures.

Lifting Equipment - Used on all engineer and construction tasks; for installation of shelters, etc., bridge building, road repairing, loading of stores and equipment, etc.

Type & Nomenclature	Weight (t)	Lifting Maximum (a) tonnes	For Capacity (b) at jib length m	Lifting Maximum (a) tonnes	For Reach (b) at jib length m	Lift Heights (Max (weight t.)	Tpt Speeds (kph)		
							Road Max	Aver. on rough road	Road Range (k)
Vehicular Cranes									
K-67	11.9	6.3	3.7	3.2	7.5	(8)11.7	40	18-22	800
K-122	22.5	12	4	2.4	10	(8.5)17	35	18-22	800
K-162M	22.8	16	3.9	2.8	10	(10)21.8	50	22-28	800
8T 26	24	10	4.5	2	9.5	10	40	18-22	660
87 210	13.6	6.3	3.5	1.8	7.5	8.1	70	25-35	450
Fork Lift Trucks									
EP-201	3.48	2	-	-	-	(1.8)4.5	12	Tpt on veh over long distances	
Self-loading Jib attached to equipment	Jib & tackle Equip only								
4033	1.2	1.1	2.5	0.55	5	7.3	65	25-39	500
4032	1.6	2	2.5	1.00	5	7.25	55	22-28	650

Details of Soviet Heavy Plant Vehicles

Type	Weight & Chassis	Blade width m (max) at 90o	Grading speed (road)	Path clearing speeds (kph)		Excavation vol m 3 per hr	Range	Max road speed kph	Cross country speed kph
				Moderate rough ground	80cm snow				
Graders									
BAT-M	ATT-27.5	5		4-8	8-10	120-200	500	35	20
PKT	MAZ 538-21	4.2	300m per hr	2-3	4-6	80-100	500	45	25
Bulldozers									
BKT	MAZ 538-20	3.33	-	2-3	3-6	80-100	500	45	25
D271	C-100 13.4	3	-	2-3	3-4	50-80	120	10	7
MotorGrader									
D144	Special 13.4	3.7	350m per hr	1	-	not suit-able	200	27	20

BAT-M also has a crane with a 2 ton lift and 5m jib.

Details of Soviet Earth Moving/Digging and Trenching Vehicles

Vehicle Type (Chassis)	Weight	Ditch		Trench			Maximum Capacity per hr	Road speed		Range
		Depth	Width	Depth	Top Width	Bottom Width		Max	cross country	
BTM-3	27.6	-	-	1.5	1.1	0.5	350m	35	20-25	500
Trencher (AT-T)				1.1	0.9	0.5	450m3	35	20-25	500
MDK-2M Digger (AT-T) with Dozer blade	28	3.5	3.5	-	-	-	300m3	35	20-25	500
E305B Universal Excavator (YAAZ214)	17.5	3.4	-	4.1	-	-	60m3	55	22-28	600

Details of Dozer Blades

Type of Vehicle	Weight tonnes	Time (mins) Mounting Dismoun -ting	Cut width (m)	Earth Level ling speed kpg	Snow clearing speed kph (0.8m snow)	Filling or excavating capacity M3 per hr	No of veh trenches or shelters dug in a given time
Tk Bulldozer blade BTU	1.4	60 — 45	3.8	5.7	4-6	130-250	3-4 per hr
Tk Snowplough STU-2M	2.5	15-25 ----- 15-25	3.6	-	-	-	-
Heavy Artillery tractor OT-T blade	2	60 — 30	3.5	3-5	4-5	80-150	5-7 shelters i 10hrs
Medium Artillery Tractor OS-T blade	1.2	60 — 30	2.8	2-3	3-4	40-80	4-5 shelters in 10hrs
Light Artillery tractor OLT	0.7	60 — 30	2.5	1.5-2	2-3	25-40	3-4 shelters in 10hrs

ANNEX J

TOPOGRAPHICAL DEFINITIONS.

It is the duty of the topographical service to draw up military-geographical and military-engineering studies of terrain for all operational axes, theatres of combat operations or sectors thereof. They contain detail of terrain, climate, population (location, attitudes, etc.) and economics of the region in question. They are illustrated and have special (engineering) maps to accompany them.

Standard Soviet definitions in estimation of the passability of mountainous terrain (expressed as variations of a norm for operational planning).

(1) Most easily passable - mountain areas with parallel valleys and ridges.

(2) Medium passable - mountain areas of a single large ridge with secondary ridges leading from it.

(3) Least passable - mountain areas with ridges running radially from a central high point.

(a) Soviet calculation tables for assessing passability of gradients to military vehicles - (assuming hard dry ground without obstacles).

Degrees of Gradient	Accessibility	
	For Tracked Vehicles	For Wheeled Vehicles
up to 5	easy	possible
5-10	possible	possible, occasional difficulty.
10-20	possible, occasional difficulty	with great difficulty and only very slowly.
20-30	with great difficulty and only very slowly.	for all practical purposes, impassable.
over 30	for all practical purposes, impassable.	

(b) Mean transit speeds over hard dry ground at various gradients.

Type of Vehicle	Gradient (degrees)			
	3-5	6-10	11-15	16-20
	Speed, kph			
Wheeled	20-15	15-12	12-8	8-5
Tanks	15-12	12-10	10-6	6-4
Prime movers	12-10	10-7	7-5	5-3

(c) Vertical obstacles to movement, rock walls, scarps, etc., in hard dry ground.

Tanks (T-55, -62, -64, -72) can overcome a vertical height of .85 - .9m.

Tractors and prime movers can overcome a vertical height of .4 - .6m.

Width of gap or trench with firm walls which can be overcome by vehicles of different types.

Tanks (all types in current use) can cross a gap of 2.4 - 2.6m.

Prime movers without trailers 1.6 - 2.0m.

Wheeled vehicles of 3 or more axles 0.5 - 1.0m.

(BTR 60, BRDM)

ANNEX K

SOVIET NBC DEFENCE EQUIPMENT.

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Appendix 1 to Annex K

NBC SIMULATORS AND TRAINING AIDS.

(a) Nuclear Burst Simulators and Chemical Attack Simulators.

The Soviet Air Defence Command (PVO Strany) has a warning and monitoring organisation subordinate to it, whose members man observation posts throughout the USSR. Equipment designed to train these observers, whilst not strictly 'battlefield' equipment, can nevertheless be used to train soldiers, and to expose them to 'realistic' conditions.

One of the more modern pieces of equipment designed for this training is a nuclear flash-bang simulator mounted on a two axle trailer. This is designed to demonstrate the primary and secondary flash effect at night, and to show the effective time delay occurring between flash and bang, so that observers can be taught to estimate yield and range effectively, and to take cover in time.

The first phase flash is provided by two 1 FK-20000/2 thirty million candela impulse lamps each giving upto 2 milli seconds flash at 5 minute intervals minimum working on 600 watts. The lamps can be used individually or in combination at half or full output, giving four 'yield' permutations.

The second phase flash is provided by two DKST-10,000 industrial lamps each giving 20,000 candela for between 1 and 20 seconds, variable to initiate the 'yield' required.

Bang effect is produced by a tape recording of an actual burst fed through loudspeakers on the trailer, and supplemented by upto five explosive charges detonated in dismounted directional cones. In this manner, upto 140 DB can be registered at 10 metres from the equipment. An automatic time delay varies the time lapse between flash and bang to simulate ranges from the burst of between 2 and 20km.

The equipment can be plugged into an industrial power supply (when training observers in urban areas or at major HQ locations) or it can be operated from a standard 25 KW generator providing 220 or 380V at 50 Hz. It takes only 20 minutes to set up.

For battlefield exercises, simpler pyrotechnic devices are more commonly used in training. Instructors are issued for their ad hoc construction in several sizes and a standard full scale version, the IU-59, exists for use on major exercises, although cost and the necessary safety precautions rule out its use at unit level. All work on the principle of a remotely detonated buried explosive charge propelling an incendiary and smoke-producing agent so as to provide a realistic 'fireball', mushroom cloud and bang. A typical small scale device for sub-unit training areas uses two artillery shell burst simulators (small PE charges) at the base of a buried 1.2m long piece of steel piping. On top of the charges is placed about 20 litres of combustible fuel (a mixture of 50% petroleum incendiary fuel, 25% petrol and 12.5% each of diesel fuel and sump oil). This can be detonated by the KPM-1 capacitor blaster between 200 and 1,000 metres from the trainees. An even simpler device can be made by mounting 5 or 6 small (IGS) or large (IF) artillery simulators on a shelf 2 metres above ground, and putting cans of fuel oil on top. The large BDSh-5 or Marine MDSh smoke pots can supplement or replace the incendiary mixture to produce a large quantity of smoke.

Chemical shell and bomb burst simulators work on the same principle, but contain no incendiary material. The aim is to create a bang, followed by a sudden smoke cloud which blows downwind. RDG hand held smoke grenades are popular for this, as are non toxic smoke grenade simulators.

(b) Chemical Agent and Radio Active Fall-Out Simulators

Having simulated the burst, the next step in the training process is to simulate the relevant contamination. Depending on the degree of training attempted, the Soviet use inert dust, active chemicals of different types, and radio-active isotopes. As a general rule, active agents are used only to train troops of the chemical service. The grenade-simulators type 1GN, 1GS, 1DG and the mine simulator 1F-50 can be loaded with substances imitating persistent and non persistent chemical agents in droplet form. The non toxic chemical compositions known as URNOV and URSOV simulate non persistent and persistent agents. The 1GN is filled with 100 grammes of URNOV and produces a 20 cu metre cloud of smoke which carries the non persistent 'fall-out' in droplet form for 50-100 metres. The grenades are used 10-20 at a time, often strung out 3-5m apart along a road for maximum effect, and remotely detonated by a PM-3 blaster. The slightly larger 1GS is used to produce simulated 'persistent' chemical contamination over 25-100 sq metres. It holds 450ml of non toxic chemical mixture. These chemicals react with detection equipment to produce 'evidence' of contamination. The large 1F mine simulator can be charged with 2 litres of 'persistent' chemical mixture to imitate aircraft bombs or chemical mines. The slow burning 1DG grenade charged with 200 grammes of 'persistent'

chemical simulator produces a dense smoke cloud for 1-3 minutes which can carry upto 500 metres with its suspended 'fall-out'. The particular advantage of this grenade is that it can be thrown, and need not be prepositioned for detonation.

If the URNOV and URSOV simulation chemicals are not available, Soviet manuals recommend alternative solutions which will react with detectors to produce 'evidence' of chemical attack. The most widely available substance is the agricultural insecticide 'Chlorofos' which, as a 3-5% solution in water imitates quite effectively an aerosol spray. This creates a positive reaction in a GSP-11 and in one of the tubes of the detector kit. Ammonia will create the same reaction as V-gasses, but monoethanalomine is more effective and more popular nowadays. The solutions used for decontamination provide ready sources of these chemicals. DT-6 chemical crystals can be used in the 1GS to provide a simulator for phosgene contamination.

To simulate a contaminated environment in a gas chamber, to train troops to wear gas masks correctly, the chemical Chloropichrin is used. Although this is not just a reagent but an irritant it is apparently not sufficiently irritating to make the troops take particular care to ensure that their mask is a tight fit. Consequently, there have recently been suggestions that a more powerful training agent be used.

The chemical contamination simulators pose only a very slight risk if ingested as they are used in very low concentrations. However, the same does not apply to the radio-active fall-out substitutes used, and strict safety measures surround their use. The normal ZMCh-P kit holds 2 containers holding 8 ampoules of radio-active dust, dispenser and handling tools for the contamination of equipment. The URP radio-active training dust in each ampoule contains an isotope having a half-life of 15 days, yielding 6 millicuries per gramme. It is dispensed onto equipment in small patches 6-8cm square to train NBC recce and decontamination personnel. It is only used under the supervision of the head of the Regimental Chemical Service or an officer of the chemical detachment. Soldiers using it must have a medical certificate to do so, and must carry an individual dose rate meter. Its use is restricted to special training areas agreed by the Military District Medical Staff, never closer than 2km to habitation or water sources, never on porous soil and never upstream of habitation. On decontamination, the effluent is run off into deep pits which are then marked. The isotope raises the residual radiation level of the equipment on which it is used. When this level exceeds 50 milli rads per hour, the 'hot' equipment is stored until natural decay renders it safe to use again.

Appendix 2 to Annex K

RECONNAISSANCE AND DETECTION EQUIPMENT.

(a) Radiation Recce

The simplest and most widespread detector for radiation is an indicator film tab attached to the left sleeve or to the exterior of AFVs. This changes colour on irradiation.

The chemical troops are supplied with several types of radiation measuring instruments and kits enabling them to measure effectively dosages received by individuals, radio activity and residual radiation. The Soviet devices in current use do not, however, register the dose of high energy radiation (neutron stream) given out at the moment of the burst (although the Hungarians have recently produced a radiation counter which does record this information). This would reduce their value considerably if enhanced radiation weapons were to be employed.

The DP-22, DP-23A and DKP-22V are dose rate meter kits carried by chemical troops in all arms units. Each soldier and officer can be issued with an individual dose rate meter tube of the type DKP-50A, DS-50 or DP-70-MP. These are all about the size of a fat fountain pen, to be carried like a pen in the pocket. They record the cumulative dose received by an individual but the DS-50 type issued to soldiers cannot be read by them, but must be inserted into the DP-23A charge meter by the commander or chemical service operator authorised. The DKP-50A and DP-70-MP can be resealed and read but soldiers who are issued with these devices are forbidden to do so. The DKP-50-U is a training individual dose rate meter which uses discharge tubes to give different dose readings for 1 hour, 1 day or 3 days. It does give a visual display and is usually issued to all officers and to two soldiers in each section.

For radiation detection and monitoring of personnel, equipment and terrain the Soviets use a variety of radiometer-roentgenometer devices of varying sensitivities and for various circumstances. Some are designed to be carried and others are for vehicle or helicopter mounting.

The light, easily portable DP-63A has two operating sub-bands, 1.5-50 rads (roentgens per hour) and below 1.5 rads, and registers radiation on an ammeter. The similar DP-64 emits an audio visual signal. The DP-36

vehicle mounted detector has 4 sub-bands, 1, 10, 100 and 500 rads and registers radiation by a light and on an ammeter. It is particularly suitable for area survey. The highly sensitive DP-5 has six sub-bands, 0.1, 1, 10, 100, 200 and 1,000 rads. It is used for mounting contamination of personnel equipment, food and water. Training kits are available for both these latter devices, permitting radio-active contamination of terrain or equipment to be imitated from 0.5 to 150 rads.

(b) Chemical Reconnaissance

Two main types of device are used by chemical troops to detect contamination by chemical agents, the GSP series of automatic detector and alarms, and the PKhR series of specific agent detector devices.

The GSP1m and GSP11 detector alarms can be mounted in vehicles or placed in chemical OPs. They will detect chemical contamination or fall-out, but not measure its intensity. The latter model is coming into more widespread use as it will detect V gasses as well as G nerve agents. They operate by means of a photocell and tape (silica gel film) particle detector, rather like a domestic smoke alarm, and give an audio visual signal for safe and danger states. They can be operated for 8 hours without recharging. As they operate by pumping air through the detector, which only reacts when a sufficient concentration is achieved, in low levels of contamination it can take some time before the machine registers the presence of an agent.

The PKhR series is designed for accurate and specific identification of contaminating agents by type and intensity following their detection by the GSP. All operate by blowing air through indicator tubes lined with a reagent which changes colour on contact with a specific contaminant. The two portable versions in current use are the VPKhR and PKhRMV. Earlier less versatile versions are still found in civil defence units and are still used in the DOSAAF for training. In both devices, the operator breaks open a glass detector tube and inserts it in the device, then operates a small pump to blow air through the tube. If no reaction is obtained, then another tube is selected which reacts to different agents and the process is repeated until all agents have been tested for. Several spare sets of detector tubes - KKT-1 - are carried. The devices have integral heating elements to warm the tubes in cold weather to above +10C, necessary for the effective operation of the reagent. Filters can be fitted to prevent reaction to smoke obscuring the results of the detectors. The VPKhR is designed for normal reconnaissance of area and equipment. Spatulas and sample jars are included for scraping vehicle surfaces and sampling soil for surface contamination. The PKhRMV is more specifically

designed for testing samples and is used mainly in the checking of food and water as well as equipment. The PPKhR operates on the same lines as the VPKhR except that it is designed for mounting in a vehicle. The sensor is remoted to the outside of the special chemical recce vehicle and reaction is indicated on the vehicle control panel. Its heater and pump are electrically driven and it also incorporates a simple rad counter. Like the portable versions, it requires smoke filters, which must be changed frequently. Its particular vices are that it is rendered insensitive and therefore ineffective by moisture, dirt or dust, and it requires a regular daily change of the silica gel reagent container. In hot climates, the containers must be renewed hourly. All these series of detectors will register all known agents, but they are said by the Soviets to be slow to use effectively and it is difficult to change batteries and indicator tubes when wearing protective gloves.

At formation (army) level, comprehensive field chemical laboratories, PKhL, are deployed permitting sophisticated analysis and experimentation to be carried out. These are usually trailer mounted box bodies fitted with collective protection.

NBC Reconnaissance and Detection Equipment.

Chemical recce vehicles (wheeled armoured and unarmoured and tracked armoured) are equipped with the GSP-11 signaller and PPKhR detectors, and carry maps, charts and graphs for calculating downwind drift and fall-out rates, supplies of formulated blanks for the standard reports, etc. The BRDM-2-rkh has gyro-navigation equipment. Vehicles are fitted with the KZO-1 marker flag dispenser. These yellow flags marked 'ZARAZHENO', (contaminated) can be fired into the ground by a blank charge detonated from inside the vehicle. Before firing, they can be fitted with a tab indicating type and intensity of contamination, and time of reading. Thus boundaries of contaminated areas can be marked without the crew having to leave the vehicle. Both vehicles carry stocks of the SKhT audio-visual rocket alarm. Because of its armour, the BRDM-2-rkh and tracked chemical recce vehicle give much greater protection, not only against conventional fire, but also against radiation.

Each Soviet formation HQ has a RAST, a reckoning and analysis cell, staffed by chemical troops. This is a term of mathematically competent personnel operating from a box bodied vehicle well supplied with maps, talc boards and formalised paperwork. Their task is to aid commanders and staff to assess the effects of the enemy's use of weapons of mass destruction by plotting hazards, estimating the masking value of terrain, etc. They are supplied with dose rate calculators and gauges, graphs and the like to

assist their speedy calculations. They are in close touch with the meteorological service.

Recent years have seen a significant increase in Soviet efforts to improve their meteorological reconnaissance. The importance of this is not restricted to NBC warfare. Accurate meteorological information is essential for accurate long range artillery fire, particularly for free flight missiles, and for shooting in hilly or mountainous terrain. The current Soviet aim is to increase the frequency of meteorological bulletins, their accuracy and reliability, and also to conduct meteorological sounding with greater secrecy.

Appendix 3 to Annex K

INDIVIDUAL PROTECTIVE EQUIPMENT.

(a) Respirators

The standard service respirator is the ShM (Shlem-Maska), a soft rubber mask fitting over the whole head, connected to a waist-carried filter canister by a corrugated hose. A version with a membrane speaking element is issued to commanders and radio operators. This covers only the face. Both versions have individual eye pieces. A third version, the ShMs, has special smaller optically corrective eye pieces to enable wearers to operate weapons sights. The ShR head mask is a loose fitting mask for casualties with head wounds.

All versions of the mask are effective against both chemical agents and radio-active particles, but the filters are too coarse to give protection against toxin particles. The masks are more restrictive, have poorer visibility, and are more uncomfortable to wear than the current British, US, Hungarian or Czech versions. They are also less resistant to damage.

Light face masks are also issued to protect against the effect of smoke, and radio-active fall-out. These protect the eyes, nose and mouth with a light pad filter, and are not designed to be effective against chemical agents. Chemical troops (and also engineer troops), especially those laying smokescreens, are often equipped with the IP-46m oxygenating respirator. This is similar to a ShM, but the filter canister contains an element producing oxygen by chemical reaction. It has a life of 2 hours.

(b) Isolating Respirators

The IP-46 and IP-46M are being gradually replaced by the IP-4 and IP-5.

The IP-4 protects respiratory organs, eyes and facial skin from all known contaminants. The IP-5 is an escape mask for tank crews stranded under water when schnorkelling, etc. It can also be used when working in a situation where oxygen is lacking.

The masks are very similar to the ones they replace.

There are three main types of protective suit issued. The L-1 light protective costume, which consists of trousers with boots, jacket with hood, and mittens; the OP-1 all arms protective cape, which consists of individual boots/leggings, with a one piece hood/cape combination and gloves or mittens. The cape can be used as a poncho, overcoat or buttoned up as a suit. The OP-1 is the standard all arms protective garment, the L-1 is issued to recce personnel, chemical defence personnel, and anyone else for whom mobility is important and long wearing times likely. A heavy duty version of the L-1 is issued to decontamination units because of the heavy wear they get. All suits are made from rubberized fabric and are as a consequence very hot and uncomfortable to wear for long periods. The OP-1 is not airtight.

Appendix 4 to Annex K

COLLECTIVE PROTECTION EQUIPMENT.

The Soviets are extending their employment of collective protection to cover not only HQ vehicles and complexes but AFVs, logistics vehicles and medical facilities. An early type of protective device, the PAZ or 'anti-atomic protection' was fitted to T-62 and late model T-55 tanks. This is radiation detector/shock wave reactor which closes automatically optical sight covers and engine ventilators and warns the crew to shut down hatches. Modern Soviet AFVs, such as the BMP and BMD, self-propelled howitzers and the T-64 and T-72 have filters and internal over pressure to give protection against both chemical agents and fall-out. Similar equipment is fitted to new logistics vehicles and HQ vehicles, and tents (such as the standard medical tents) can be equipped with filtered air supply and positive internal pressure.

A certain element of crew protection against nuclear radiation is provided by the design features of some armoured vehicles. For example, all Soviet tanks have their armour distributed more evenly over their total armoured surface than do Western tanks in current service, which tend to concentrate their armour on the rear and front sides. Thus a tank crew is better protected from high intensity radiation and neutron streams from an air burst than is the crew of a Western tank. Whilst it cannot be claimed that this consideration has played a crucial part in Soviet tank design, it may well have been a minor influencing factor. Many Western experts believe that the latest Soviet tanks and APCs/BMPs are lined with a lead impregnated plastic foam to increase crew protection against high intensity radiation and neutron bombardment. Most recent Soviet articles do however maintain that AFV crews are not effectively protected against the neutron stream and initial penetrating radiation. Trends in other areas of military technology have had a spin off in NBC terms. For example, the almost complete mechanization of handling of ammunition and other supplies and the palletization of shells with protective polythene covers has made decontamination of stocks easier and handling much simpler. The spread of pillow tanks for fuel storage and transportation has likewise made for ease of mechanical handling and ease of decontamination. The increase in troop transport available provides a great deal of protection for the individual and reduces the problems of personal decontamination for radio-active matter even when collective protection is not installed.

Appendix 5 to Annex K

DECONTAMINATION EQUIPMENT AND AGENTS.

(a) Personal Decontamination Kits

All Soviet personnel carry the 1PP personal anti-chemical pack and/or 1DP-S individual degassing and anti-chemical pack; the individual medical treatment pack; and a field dressing. The 1PP pack carried by the soldier contains: two small phials of decontaminant, one for use against nerve gasses, the other (Chloramine-B) against vesicants; four anti-smoke capsules (containing a dilute mixture of ethanol, chloroform, ether and ammonia); and gauze pads. In each AFV is carried the 1DPS-69, a cardboard box containing 10 1DP-1 packets and 10 DPS-1 packets, sufficient to decontaminate between 5 and 10 personal weapons and 10 suit kits.

The 1DP-1 individual degassing and anti-chemical pack is a disposable kit consisting of cotton wool swabs and an aluminium vessel of 200ml volume filled with a liquid decontaminant effective against agents in droplets or moisture form at between +50o and -35o temperatures. The personal weapon (AKM, AK-74) should be decontaminated with rags soaked in the solution, starting at the barrel and working downwards, not forgetting the sling - a common error. The weapon is then dried and oiled well. One packet will suffice to cleanse an AK, two an RPK and three a PKM.

The DPS-1 pack consists of a gauze bag dispensing an alumo-silica catalytic absorbent powder, sealed before use in a plastic bag. It is useful for decontaminating field uniform contaminated with soman vapour; in this instance the contents of the packet are simply sprinkled over the soldier's uniform by a colleague. Liquid contamination must be dealt with using 1DP liquid decontaminant.

(b) Equipment Decontamination Kits

Chemical troops carry supplies of larger kits for the partial decontamination of field guns, mortars and other large items of equipment. In event of a high risk of contamination, these kits are issued to crews for their use. The ADK (for field guns) and PM-DK (for heavy machine-guns, mortars and the like) both consist of various decontaminant solutions or powder, cotton wool, spatulas and brushes for application.

(c) Wash-down Decontamination Devices

Tanks, SP guns, BMPs and tracked APCs all carry TDP 'Tank Degassing Devices' mounted on the vehicle. These resemble, in looks and in method of operation, small fire extinguishers. They are in fact two-litre pressure bottles for use by the vehicle crews. On discharge, they spray a decontaminating agent at 8-10kgs per sq cm pressure. They are used at 20-50cm from the contaminated surface of the vehicle to give a partial wash-down.

Chemical troops hold a variety of wash-down devices which are issued to vehicle or gun crews, or all arms soldiers for wash-down decontamination of weapons, vehicles, buildings and indeed any equipment. These devices are also operated by the chemical troops themselves. The lDK set is the simplest device. It consists of a hand pump (or attachment for coupling to a vehicle compressor) and a hose and brush set. The device attaches to a standard jerrycan which is filled with a decontaminating solution. The RDP system is virtually identical except that it is attached to a purpose made tank. The DKV set operates on similar principles, but with a 30 litre cylindrical tank and two hose-brush attachments. It too operates from a vehicle compressor but cannot be powered by a hand pump.

The DK-4 system is powered by a rotary pump attached to the exhaust system of a lorry or AFV. It too has a decontaminant reservoir and hose-brush sets but unlike the other systems mentioned above, it can be switched to produce a vacuum to suck up radio-active dust.

As a general rule, the crew of a lorry or AFV can thoroughly decontaminate their vehicle with 2 or 3 of the larger devices (DKV or DK-4) in about 30-45 minutes. As 60-70 litres of decontaminant are needed to clean a tank thoroughly, the 78 DKV devices, for example, carried by the divisional chemical services could decontaminate at least two companies of tanks.

(d) Mass Decontamination Devices

Equipments in current use of chemical units are the DDA-53 lorry mounted decontamination shower unit; the AGV-3M vehicle mounted decontamination station; the ARS-12 and 14 vehicle mounted wash-down units and trailers; the TDP tractor drawn decontamination trailers; and the TMS-65 jet sprayer.

The DDA-53 consists of a boiler and two steam chambers mounted on a medium truck chassis (e.g. GAZ-63). The steam chambers can be used with or without a contaminant chemical to clean uniforms, weapons and equipment in the field. The boiler can also be attached to shower units erected in tents for decontamination of personnel. One vehicle can clean all the personal weapons or all the field uniforms or give showers to all personnel of a motor rifle company in about an hour in summer conditions. In winter, the same treatment takes 1.5 hours.

The AGV-3M complex consists of 4 medium trucks (ZIL-157-130); one equipped with a steam and hot air generator; two steam chambers; and the fourth, a cargo vehicle, carrying two tents, a pillow tank and sundry items of hose and equipment for erection of the complex.

The boiler vehicle provides superheated (200 °C) steam to the steam chambers for the decontamination of clothes and equipment; hot water to a shower tent; and hot air to a drying tent at a rate of over 300 cubic metres per minute. The cargo vehicle also carries two simple boiling vessels for items which can be boiled. Decontaminating agents can be introduced into the steam and water if necessary.

The complex can be erected or dismantled in less than two hours. In winter conditions, the complex could decontaminate personal clothing and equipment, and provide showers for an entire motor rifle battalion in about 8 hours. Water for both the DDA and AGV equipments is most often supplied from PDB-5000 pillow tanks.

The ARS-12 and ARS-14 vehicles consist of a large tank of 2,500 and 2,700 litres volume respectively; mixing chambers for decontaminant additives (and in the case of the ARS-14 foam additives for fire-fighting); 5 hose attachments and 8 hose-brush attachments. Water or decontaminant is pumped under high pressure to the hoses for radio-active wash-down, and under low pressure to the hose brushes for scrubbing off chemical contaminants.

The vehicles carry enough liquid to decontaminate upto 25 tanks or APCs and over twice that number of field guns or similar equipment. They can also be used to spray roadway at the rate of 1 litre per square metre. The capacity of the ARS vehicles can be increased if they tow the TS-2, a tank of 1,600 litres capacity on a two axled trailer.

Both the Polish and Czech Armies deploy a modified version of the ARS

vehicles which are equipped with water heaters for winter use.

The TMS-65 machine consists of a Viktor Klimov 1-A turbo jet motor mounted on a URAL-375 lorry (or on a 4 axled trailer) together with a 1,500 litre tank for decontaminant. The TS-2 trailer tank can be attached to extend the decontaminant supply. Controlled by an operator who sits in an enclosed cab next to the rearward facing jet engine, the hot exhaust gasses of the jet engine decontaminate vehicles; a decontaminant solution can be added to the exhaust at a rate of 200 litres per minute producing a very effective intermittent spray of droplets. The engine can be run for 2 hours on its 1,500 litre supply of fuel.

Standard practice is to site 2 TMS vehicles on opposite sides of the road, staggered by 25 metres; vehicles pass at 2-3kph at 25m intervals between the 2 jets at a range of 5 metres where the gas or gas-droplet stream is 15 metres wide. Consequently the decontaminating stream plays on each side of the vehicle for 60-90 seconds. If a third, trailer mounted engine is available, it usually plays obliquely onto the front of the vehicle.

Given an adequate supply of fuel and water, these equipments can decontaminate large numbers of AFVs very quickly with minimum effort. The main problems associated with this system are occasioned by the vehicle driver's difficulties in driving accurately through the intense heat and noise of the jet stream.

The improved Czech version of this machine, the TZ-74 is virtually identical in principle and operation. It has an M-701-C500 jet engine on a TATRA-148-PPR15-VNM 6x6 chassis, with a 5,000 litre tank for water and decontaminant and a 2,000 l fuel tank.

(e) Decontaminating Agents

The Soviet Army uses a variety of chemicals, either singly or in combination, for decontamination. The following are amongst those most frequently mentioned in the Soviet press for use with all decontamination devices. The heat alone of the TMS-65 exhaust destroys most chemical and biological contaminants, but a 3-5% solution of calcium hypochlorite increases the effectiveness of this system.

Single Formulae

DTS-GK	-	3 parts calcium hypochlorite plus 2 parts calcium hydroxide (1:20 in water)	all chemical and biological agents
DT-6	-	hexachloromelamine (1:20 with water)	all chemical and biological agents
DT-2	-	dichloramine (1:2 with water)	vesicants
DT-1	-	monochloramine	vesicants
SF-2U	-	a powerful detergent in powder form	radio-active contamination

Compounds

DR No 1	-	hexachloromelamine 10% in dichloroethane	all chemical agents
DR No 2	-	monoethanolamine 5% sodium hydroxide 2% ammonia 20% (in water)	nerve agents (G)

DR No 1 and No 2 and DTS-GK are highly toxic and corrosive. DT-6 and DT-2 ignite spontaneously on contact with petrol and oil or other organic products. Dichloramine, solvent for most of the above agents is highly poisonous. Only DT-1 is used on the skin.

ANNEX L

AN EXAMPLE OF NORMS OF TRAINING.

On the Surprise Command:

'Gases' (ShM mask)	'Put on Respirator' (1P4)
1. Hold breath.	1. Put down personal weapon.
2. Close eyes.	2. Take off headgear.
3. Put down personal weapon.	3. Take out respirator.
4. Take off headgear.	4. Put on partial mask over chin and nose and fasten the two non-elasticated ties around the appropriate parts of the head.
5. Take out gas mask. Hold by lower part of face piece in both hands, with large fingers inside remainder of fingers outside.	5. Press the nose piece into the nose.
6. Settle chin into lower part of face piece and with sharp upwards and backwards movement of hands pull mask onto face without creases and with eye-pieces in line with eyes.	6. Put on headgear.
7. Straighten out wrinkles and distortions in mask.	7. Unseal the respirator and put the cover into the carrying bag.
8. Breathe out deeply.	8. Button up carrying case.
9. Open eyes.	9. Continue with task.
10. Breathe in normally.	
11. Replace headgear.	
12. Button up carrying case.	
13. Continue with task.	

Mistakes reducing mask by 1 degree (i.e. reduces 'excellent' to 'good', etc.).

Mask - on putting on mask, failure to hold breath or close eyes; failing to breathe out deeply when mask is on.

- Getting wrinkles in face piece or getting corrugated tube kinked.

Respirator - Failing to push nose piece up into nose.

Mistakes resulting in a score of 'unsatisfactory'

Both - Getting such large wrinkles in face piece that the gas tight seal with the skin is not complete.

- Failing to screw up the filter or connecting tube tightly.

Time Norms.

	Excellent	Good	Satisfactory
Mask	7 secs	8 secs	10 secs
Respirator	11 secs	12 secs	14 secs

Any longer time is automatically unsatisfactory.

ANNEX M

SOVIET LOGISTICS VEHICLES AND TRAILERS.

1. Heavy Cross Country Trucks.

	KRAZ-214 6x6	KRAZ-260 6x6	ZIL-135 8x8	MAZ-535A 8x8	MAZ-537 8x8	MAZ-543 8x8	KAMAZ 5320 6x4/6x6
Load Capacity (tonnes)	7	10	8	17	25	19	8+
Trailer Capacity (tonnes)	50	50 (est)	20	50	75	50	11.5
Carrying Capacity (pers)	3+18	3+18 (est)	3+16	4	4	4	3+20 (est)
Range (km)	530	630	500	900	650	500	350 (est)

2. Personnel, Goods and Load-Carrying Vehicles.

	UAZ-69 4x4	UAZ-469 4x4	GAZ-66 4x4	ZIL-131 6x6	URAL-375 6x6
Load Capacity (tonnes)	.62	.60	2	5	7.5
Trailer Capacity (tonnes)	.80	.85	2	6.7	10
Carrying Capacity (pers)	8	7	2+12	3+24	3+24
Range (km)	520	475	700	525	600

3. Special Vehicles.

	GT-SM (tracked amph)	GT-T (tracked amph)	MT-LB (tracked amph)	AT-S (tracked)	ATS-59 (tracked)	AT-T (tracked)	PTS (tracked amph)
Load Capacity (tonnes)	1	2	2.5	3	3	7-8	5 land(est) 10 water
Trailer Capacity (tonnes)	2	4	6.5	16	14	25	2 land(est) 4 water (est)
Carrying Capcity (pers)	2+10	3+20	3+10	2+20	2+14	2+2-	upto 70
Range (km)	400	500	500	350	350	900	300

4. Trailers.

a. Trailers.

Vehicles Designation	Trailer Designation	Payload	Type
GAZ-69	GAZ-704	.5+	cargo
ZIL-131	GKB-83011	3+	special
URAL-375	SMZ-810	4+	cargo
KRAZ-255	MAZ-8925	7+	special
KAMAZ-5320	GKB-8350	8+	cargo
MAZ-5335	MAZ-8378	14.5+	cargo
MAZ-537P	ChMZAP-5208	40+	transporter

b. Articulated Semi-Trailers

Vehicle Designation	Trailer Designation	Payload	Type
KRAZ-255V	MAZ-938	13.5+	special
MAZ-6422	MAZ-9398	26.5+	cargo
MAZ-537	ChMZAP-990	52+	transporter

ANNEX N

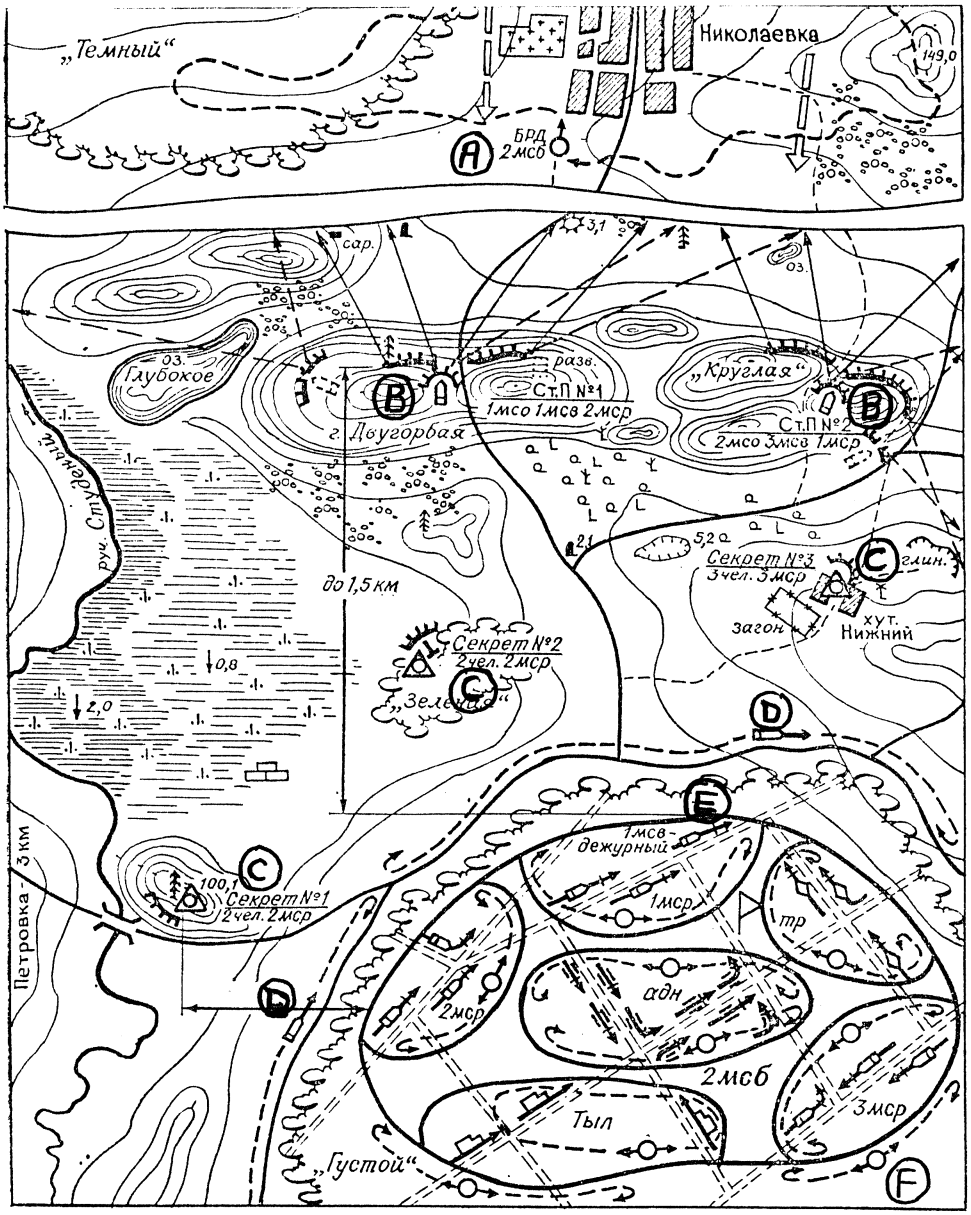

Figure 57. Local Security Measures for Units in thr Rear Area (Motor Rifle Battalion)

Key to Figure 57.

A - Combat Reconnaissance Patrol of the battalion: section or platoon strength and posted on the most probable axis of the greatest enemy ground threat.

B - Outposts: each of section strength, dug-in with section BMP.

C - Listening posts: 2 or 3 men in each. Would hope to observe recce-diversionary groups crossing open ground to reach battalion main platoon.

D - Vehicle patrols: moving on roads or tracks outside the main perimeter.

E - Duty platoon: quick-reaction counter-attack force.

F - Paired patrol: 2 man sentry providing close-in security on the main perimeter or within sub-unit areas. Each sub-unit (companies, artillery battalion and battalion rear services) provides its own "paired patrol".

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MS — Morskoy Sbornik - "Naval Collection" - Naval Officers Monthly Journal

TS — Tyl i Snabzheniye - "Rear and Supply" - Rear Services Journal

SV — Sovetskiy Voin - "Soviet Serviceman" - Popular Magazine

VV — Voyennyy Vestnik - "Military Herald" - Soviet Battalion Level and Training Magazine

VOYENIZDAT — Official Military Publishers, Moscow

ZVO — Zarubezhnoye Voyennoye Obozreniye - "Foreign Military Review" - Magazine for studying the foreign military

SMR — Soviet Military Review - Monthly journal in several foreign languages (e.g. English, French, Arabic, Dari, Spanish) to educate Third World armies in Soviet militry philosophy.

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